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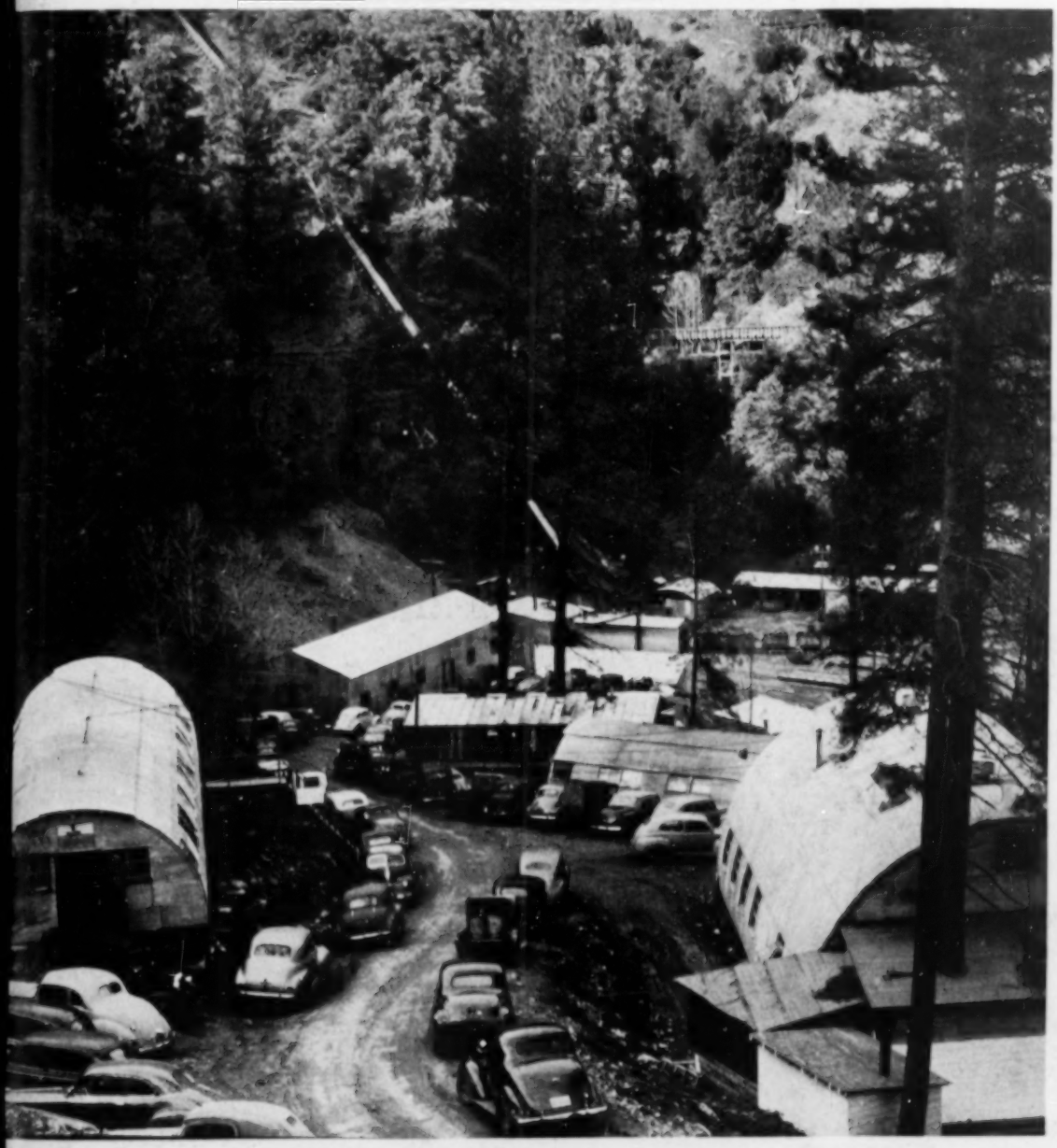


TUNNELERS' CAMP IN COAST CANYON

Home of Morrison-Knudsen forces at Adit 2 of long bore on Mokelumne River

VOLUME 53 • NUMBER 5

NEW YORK • LONDON

YOU

can profitably use one or more of these ROTARY IMPACT TOOLS

NO KICK
NO TWIST
EVEN ON THE TOUGHEST JOBS

AMAZING all-purpose ELECTRIC TOOL will

- Drill up to 1/4" dia.
- Ream up to 1/2" dia.
- Tap up to 1/2" dia.
- Run Nuts up to 3/8" dia.
- Drive Screws up to 3/8" dia.
- Hole Saw up to 1 1/2" dia.
- Bore Wood up to 29/32" dia.
- Drive Studs up to 3/8" dia.
- Drill Masonry up to 3/8" dia.
- Extract Broken Studs up to 3/8" dia.
- Wire Brush up to 3/8" dia. shanks.

(Uses Standard Attachments)
(110 V or 220 V Models available)

Only one Ingersoll-Rand *all purpose* Impact Tool is required to perform all of the operations listed. The ratings are very conservative and many jobs in excess are being easily handled by the powerful "rotary impacts".

What other electric tool will permit you to do these tough operations without any kick or twist to the operator? Plug it in any wall socket—it is reversible with full power in either direction—it weighs only 6½ pounds, but what an amazing tool for getting all those jobs done!

Ideal for installation crews—one manufacturer has equipped his installation crews with IMPACT Tools and attachments. Now, in place of 3 or 4 electric tools they carry only one and also save from 10 to 20 percent of the installation time.

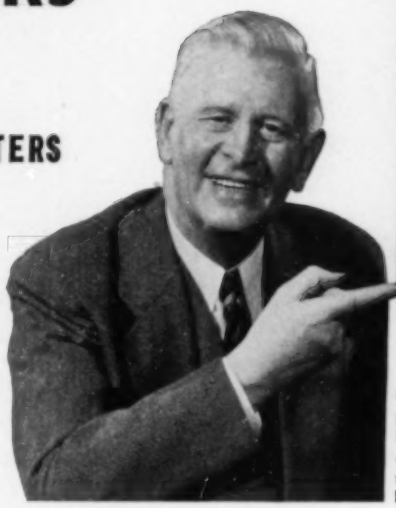
Don't hesitate, call your nearest distributor now for a demonstration of this labor saving—time saving *all purpose* IMPACT Tool. They're available for immediate delivery.

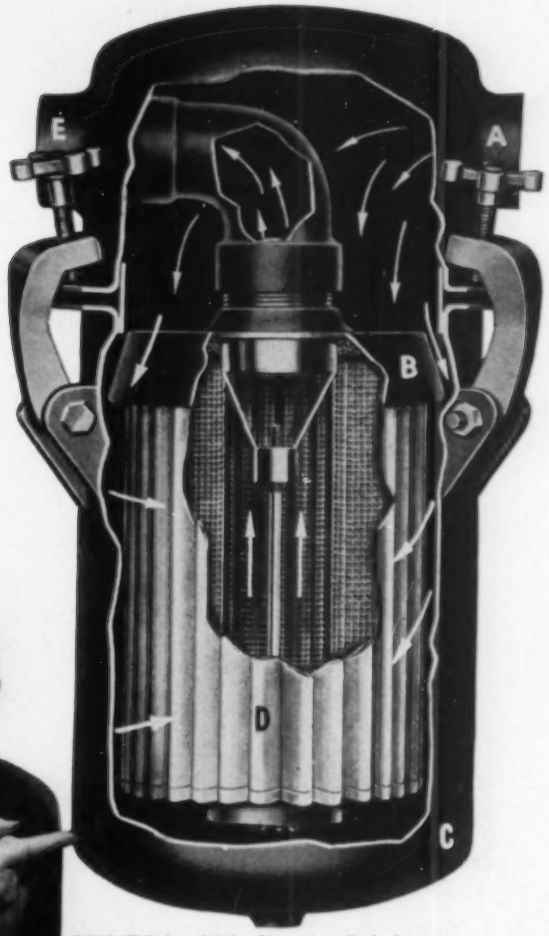
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 194-18

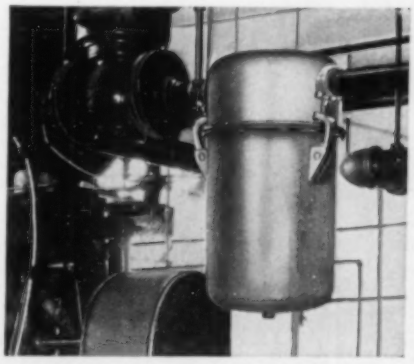
ELIMINATE VACUUM PUMP REPAIRS

USE STAYNEW VACUUM FILTERS





OPERATION — With filter installed between process and pump, dirty air enters at (A), striking baffle (B). Heavier particles of moisture and dirt are driven to the bottom of shell (C). Passage of smaller dirt particles is prevented by Radial Fin Insert (D). Clean, dry air *only* enters pump from (E).



A Staynew Vacuum Filter installed by a glass bottle manufacturer saved more than twice its cost every year. As a result, in a recent plant expansion, 10 additional Staynew Filters were placed in service to take advantage of these continuing savings.

COSTLY vacuum pump repairs, caused by intake of abrasive material, are unnecessary. Such repairs can be positively prevented at relatively low cost by the installation of Staynew Vacuum Filters.

Today, hundreds of these filters save time and money in the food, glass, ceramic, steel, chemical and other industries.

Featuring the original Staynew Radial Fin Construction, the high efficiency of Staynew Vacuum Filters makes them ideal for laboratory use.

Models available for both wet and dry process pumps. Special materials can be furnished on request.

COMPLETE INFORMATION ON REQUEST

IN CANADA: McCarthy and Robinson, Toronto Engineering Equipment Co., Montreal

DOLLINGER CORPORATION

FILTERS EXCLUSIVELY SINCE 1921

7 CENTRE PK., ROCHESTER 3, N.Y. • REPRESENTATIVES IN PRINCIPAL CITIES

DOLLINGER REG. PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS

Life-Line...

HAZARDOUS CLIMBING by maintenance men to lubricate motors mounted overhead in hard-to-get-at places, is done away with for periods of five years or more with Life-Line motors. Pre-lubrication eliminates need for customary 3 to 9-month greasing. Seals prevent lubricant from escaping from bearing regardless of mounting position of motor.

FREQUENT DISASSEMBLY of machinery housings to reach inaccessible motors for greasing is no longer necessary. Life-Line motors are pre-lubricated—need no further checking for five years—or longer. Production interruptions are reduced—as well as danger of neglected bearings.

TORTURE CHAMBER. Grueling tests like this in "torture chambers" of hot, whirling emery dust for extended periods of time—far more extreme than encountered in usual service—prove that bearing seals prevent entrance of damaging dust. Grease showed no trace of emery dust after test.

INDUSTRY'S MODERN, PRE-LUBRICATED MOTOR SUPERSEDES OLD METHODS OF MOTOR MAINTENANCE

Forget your previous ideas about maintenance! Traditional means of maintenance were discarded when the Life-Line motor was designed.

Today, as a result, many of the most troublesome items of motor maintenance can be eliminated. Life-Line motors do away with need for frequent greasing attention. Pre-lubricated bearings seal grease in—keep dirt out—need no attention—for five years or more. Danger of bearing burnouts by overgreasing is eliminated.

Pre-lubrication is just one of the ways that Life-Line motors bring totally new benefits to builders and users of motor-driven equipment. Heavy structural steel gives new shock resistance . . . cuts space requirements as much as 35% . . . provides up to 134% more torque per pound of weight. New stator slot designs and insulating materials give new and higher electrical strength.

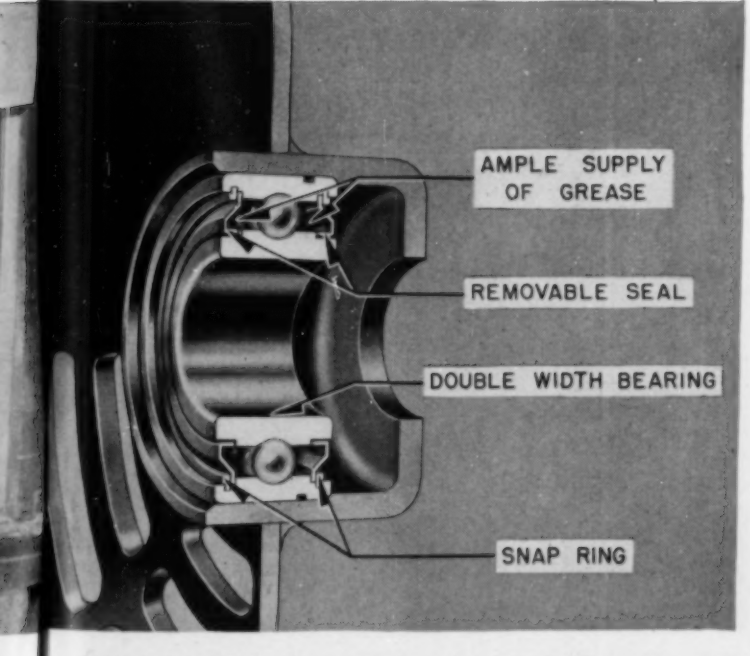
Life-Line motors, now built in sizes from 1-15 hp, are available in standard and near-standard types from stock. Soon other Westinghouse integral motors—up to 200 hp—will be changed over to modern Life-Line design. Check your nearest Westinghouse office for deliveries—or write for full details, to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-21455

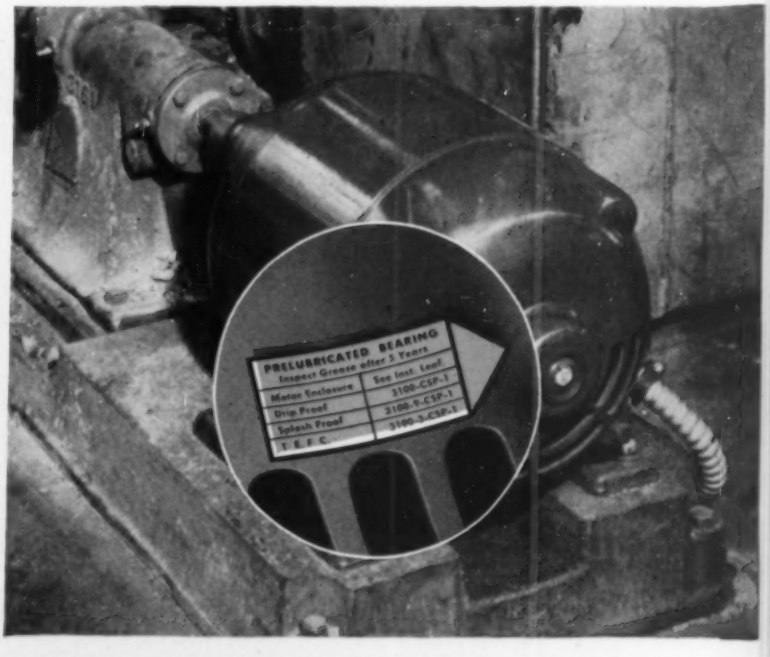
Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Life-Line motors

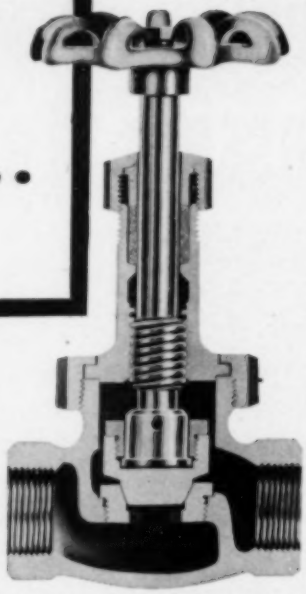


DIRT STAYS OUT—grease stays in! Pre-lubricated sealed bearings eliminate grease seepage . . . insure adequate lubrication . . . prevent "straight-through" grease waste and starved bearings that are possible where grease inlets are located directly over grease outlets as in many ordinary designs.

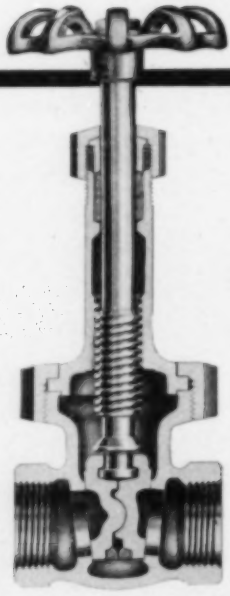


FORGET IT—FOR 5 YEARS! Westinghouse pre-lubricated bearings have been field-tested and proved for many years in the hot, lint-laden atmospheres of textile mills. *Many have been in continuous operation for over ten years without attention—positive proof of pre-lubrication savings!*

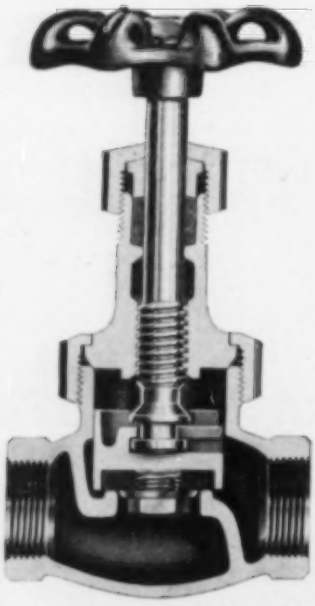
Walworth bronze valves...



Walworth No. 225P Globe Valve
500 Brinell Seat and Disc



Walworth
No. 29 Gate Valve



Walworth No. 95 Globe Valve
Re-New-Disc

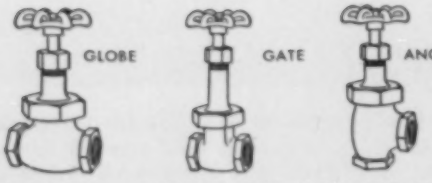
built to give dependable trouble-free service on all recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bonnets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

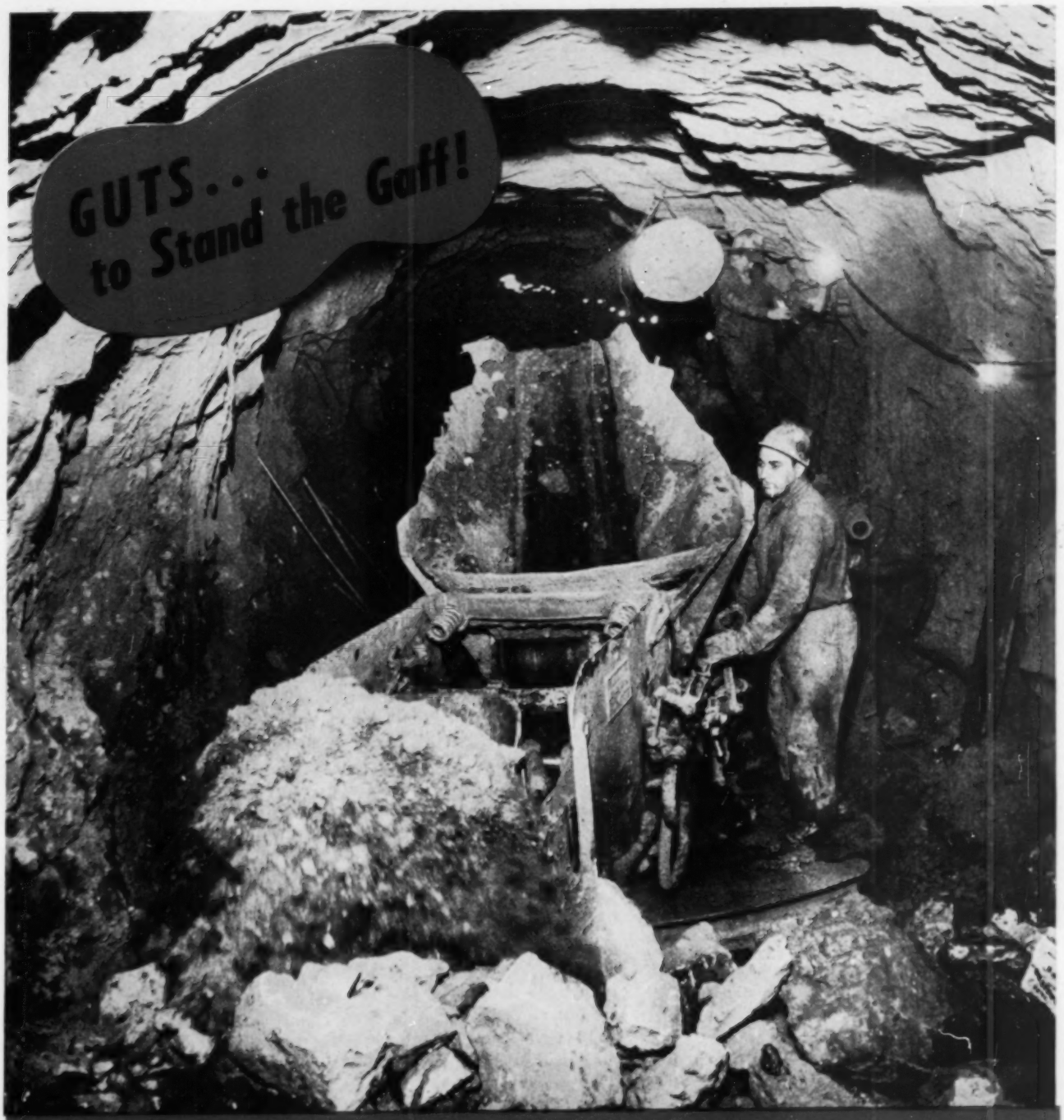
For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:



WALWORTH
valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



Completing the Big Thompson project in Colorado the Tunnel Contractors, Inc. are using Eimco Model 40's on both ends of one tunnel and averaging better than 100 ft. a day advance in the 12' x 12' bore.

High speed tunnel driving requires dependable, heavy duty equipment. Eimco RockerShovels have answered the requirements set by the contractors and are turning in record advance figures every day.

Investigate the Eimco Model 40 for your large tunnels. Write for Bulletin L-1009.

EIMCO

THE EIMCO CORPORATION

The World's Largest Manufacturer of Underground Rock Loading Machines

Executive Offices and Factories: Salt Lake City 8, Utah: Branches — 67 Wall St., New York 5 — 2319 So. Wallace St., Chicago 16 — Mills Bldg., El Paso — 1217 - 7th St., Sacramento 14 — 110 Malaga, Birmingham 9, Alabama

Foreign Branches — Hexham, Northumberland, England — 29 Rue de Mogador, Paris (9e), France — Manila, P. I.

. . . because *Condor* Homo-Flex is the "Easier Handling Hose"

The name "Homo-Flex" embodies the two most important engineering principles in this modern hose construction:

HOMOGENEOUS

The hose wall, tube and cover are one homogeneous unit of Flexlastics. There can be no separation from the cord Strength Member to shorten the life of the hose.

FLEXIBILITY

Strength without Bulk results in a hose that has been called "Flexible as a Rope."

These two features, Homogeneous Construction and Flexibility, spell "Homo-Flex." To the man who must constantly handle hose, attached to portable air tools or other moving equipment, the superior qualities of Condor Homo-Flex Hose are quickly admitted. "The work goes easier" he says . . . and the extra production per shift proves it.

Condor Homo-Flex Hose lasts longer, too. It takes sharper bends without kinking. Its new construction "gives" and "takes" with the rapid surges of working pressure so that constant pounding cannot weaken the hose wall.

Standard types of Condor Homo-Flex include Air Hose, Oil-Proof Air Hose, Water Hose, Orchard Spray Hose, Paint Spray Hose, Creamery and Packers Hose, Pressing Iron Hose, Butane Hose, Suction Hose, Rock Dusting Hose. Send for free bulletin.

(Note: Manhattan engineers have recently developed Ray-Man Homo-Flex Air Hose with Rayon for strength and lightness)

("Flexlastics" is exclusive with Manhattan)

RAYBESTOS R M MANHATTAN

RAYBESTOS-MANHATTAN INC.

Keep Ahead with Manhattan

MANHATTAN RUBBER DIVISION PASSAIC, NEW JERSEY

He works for you

He's a field engineer specializing in wire-rope problems. He works for Bethlehem, but he also works for you.

Let's say you operate machinery that uses wire rope. Maybe you haven't been getting maximum service from your lines and don't even realize it. Maybe they haven't been lasting as long as they should, and it's costing you money, whether you know it or not.

A spot like that is where the Bethlehem man can help. He knows wire rope, all the many sizes and types and grades. He also knows the kind of machines you use—how they work, what they do; why they need a certain lay of rope, a certain type of core.

If you'll ask him to study your needs, he'll give you a prompt analysis and recommend the proper ropes. He'll show you ways to get the most out of them. Both are points that have a vital bearing on rope life and efficiency.

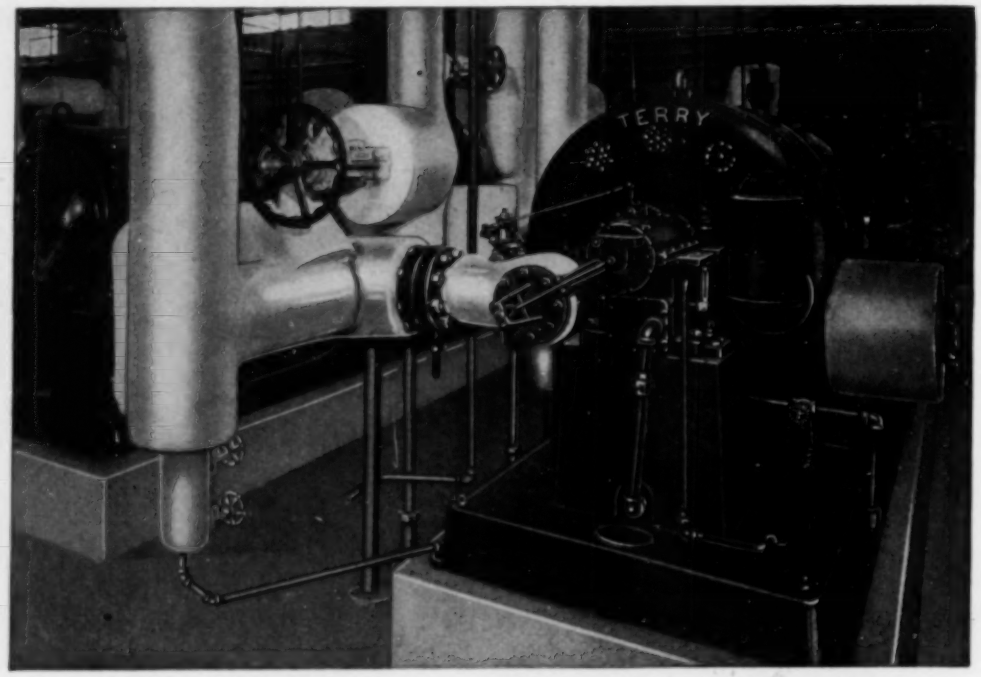
No matter where you are, the Bethlehem man is glad to be of service to you. Call him in whenever you need him... doesn't cost you a penny.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

When you think WIRE ROPE
... think BETHLEHEM

TERRY



GENEROUS BLADE CLEARANCES IN THIS 900° TERRY WHEEL TURBINE INCREASE DEPENDABILITY . . . .

The 290 H. P. Terry Turbine shown above is used for Boiler Feed Pump Drive in a recently completed central station. It operates with steam at 850 lbs.-900° F. and employs a Terry one piece wheel, as illustrated at the left.

The blades of this Turbine have large radial and axial clearances. They are further protected by projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced. It is therefore impossible for the blades to foul.

The side clearance is very large - one inch - so that end play can do no damage.

Such construction makes for dependable operation.
- Descriptive bulletins sent on request. Ask for S-116.

T-1167

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

TOTALLY ENCLOSED . . . FAN COOLED

THE above 350 H.P., 3600 R.P.M., Motor, is typical of the redesigned line of Burke large totally enclosed fan cooled squirrel cage induction motors. They are available in sizes 250 to and including 500 H.P. for direct driving high-speed blowers, pumps, compressors and like equipment installed under conditions involving dust, abrasives, conducting materials, or excessive moisture. These large motors are also available at 1800 and lower R.P.M. with either sleeve or ball bearings. Let's have your problem.

BURKE 350 H.P. 3600 R.P.M.

(Specs. for Above)

55°C Rise, Continuous
3-phase, 60 cycle, 440 volts
Full voltage starting
Starting torque.....70%
Pull out torque.....250%
Full load current..400 amps
Locked rotor current
2500 amps

BURKE ELECTRIC COMPANY 2085 W. 12th ST. ERIE, PA.

UNIVERSAL MOTORS 1/50th to 1½ HP

SINGLE PHASE MOTORS to ½ HP

INDUCTION MOTORS 1 to 1500 HP

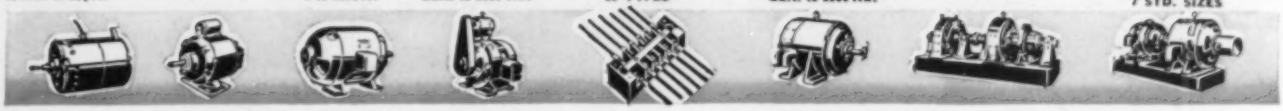
SYNCHRONOUS MOTORS to 1500 HP GEN. to 1000 Kw.

TERMINAL BLOCKS 10 TYPES

D. C. MOTORS to 1500 HP GEN. to 1000 Kw.

M-G SETS to 1000 Kw.

HIGH CYCLE M-G SETS— 7 STD. SIZES



What keeps a compressor drive . . .

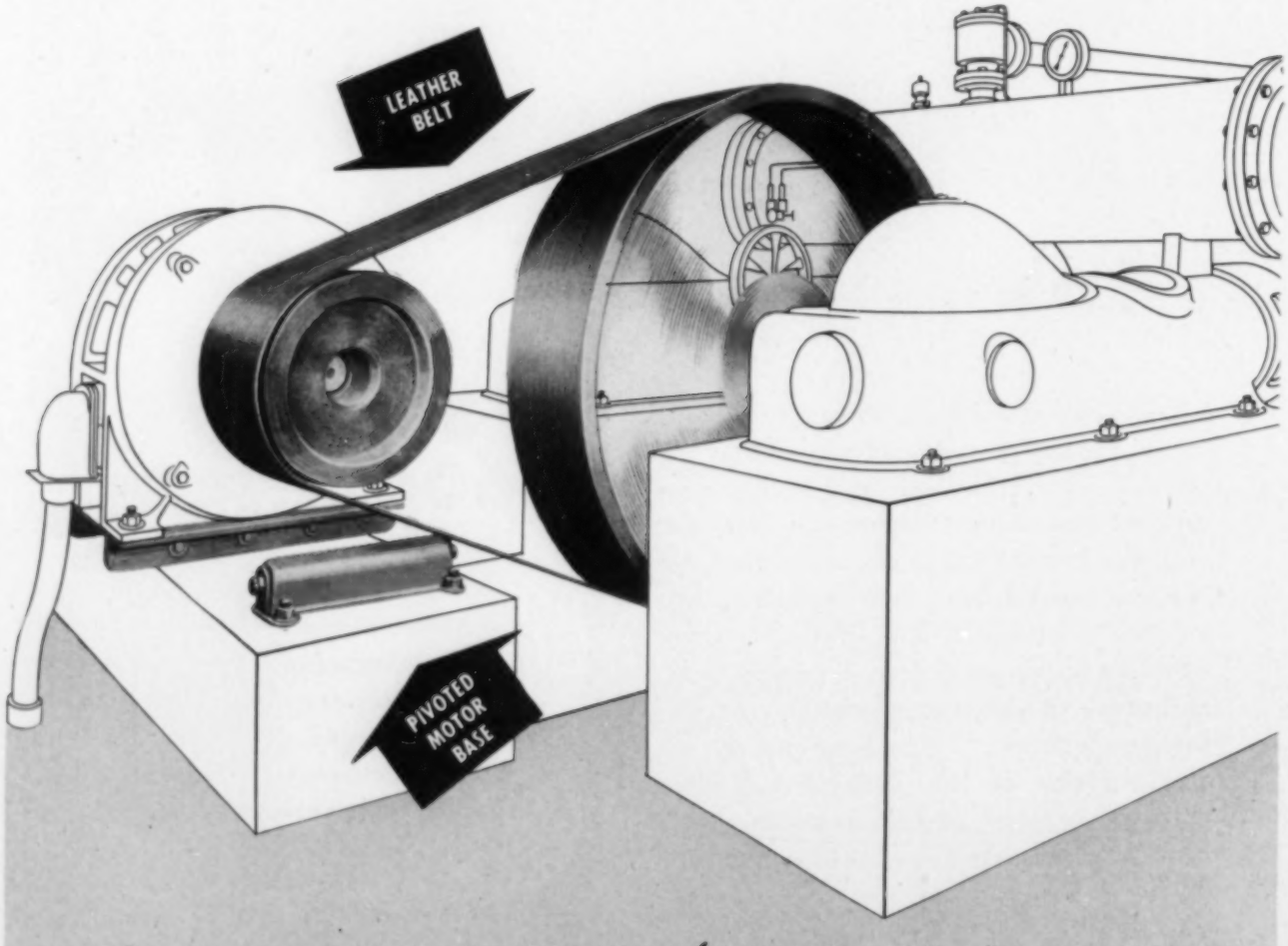
There are two things that keep a compressor drive operating with maximum efficiency and minimum maintenance: A *first quality leather belt* and a *pivoted motor base.*

The belt provides strength, stamina and a pulley-grip that enables it to transmit heavy loads with less tension. The natural, self-adjusting resiliency of the belt cushions shock; saves wear on motor and compressor bearings.

The base gives automatic, instantaneous compensation in belt tension for changes in load. It makes the belt "lean" into the heavy loads; lets it "relax" when the load returns to normal.

For the long haul over short centers, use flat leather belt and a pivoted motor base. AL-16

"Young and Carefree"?

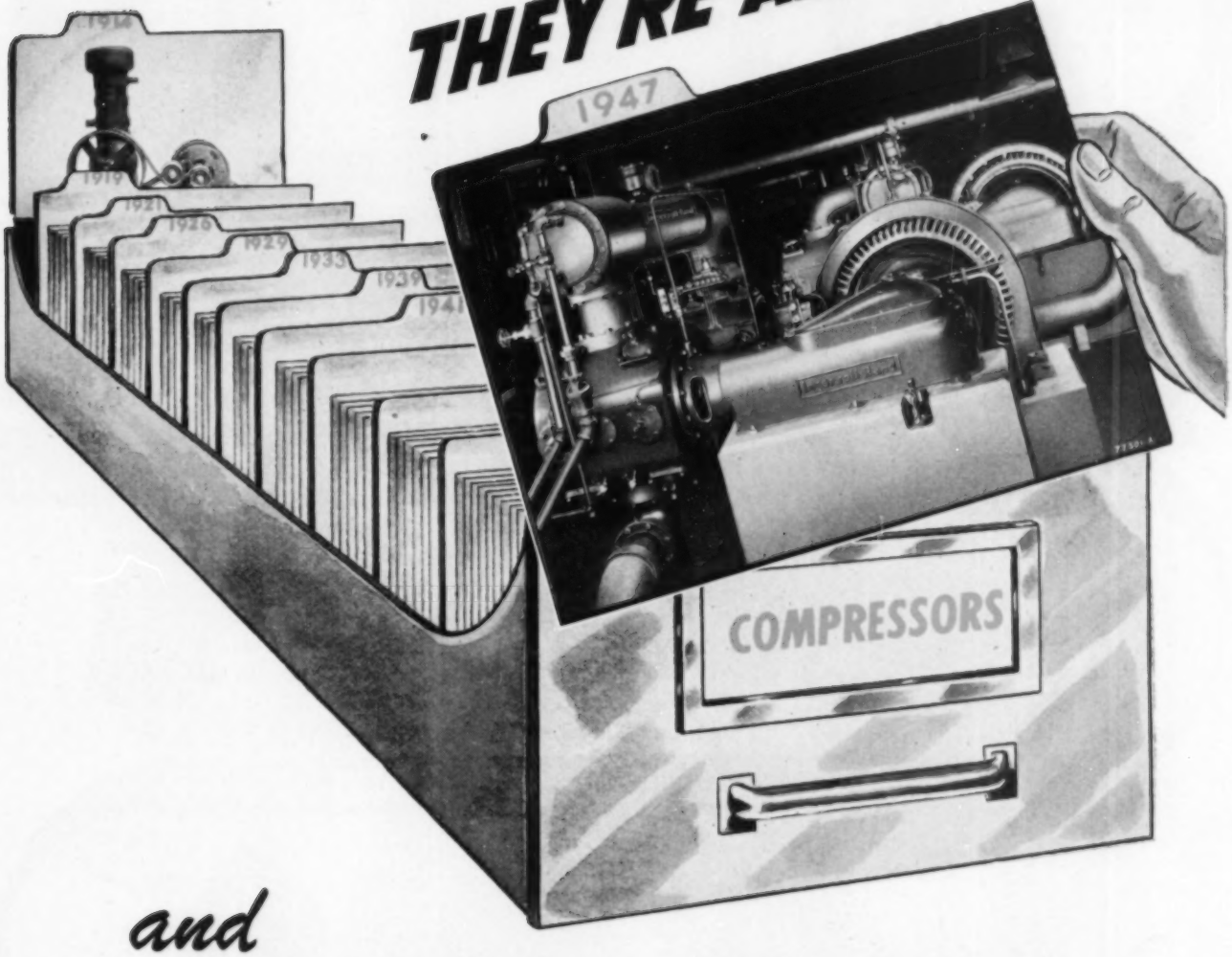


American LEATHER BELTING *Association*

Headquarters for Authentic Power Transmission Data

41 PARK ROW, NEW YORK 7, NEW YORK

THEY'RE ALL I-R



and

ALL OPERATING TODAY!

34 YEARS of trouble-free service...and still in daily use. That's the record of a Wisconsin manufacturer's first Ingersoll-Rand compressor, installed in 1914.

Many times since then more capacity was needed. Each time another compressor was installed it was an I-R. Today there are 12 of them, newest of which are three Type XRE, direct-connected, synchronous-motor-driven units. From experience, this manufacturer knows that Ingersoll-Rand compressors are economical, dependable, and long-lasting.

It is interesting to note that all these compressors were purchased through the same I-R Engineer. In each case his knowledge and experience played a major part in the selection of the proper machine for the job.

When you need Air-Power, let one of our trained engineers give you the same help with your problems.

COMPRESSORS • AIR TOOLS
ROCK DRILLS • TURBO BLOWERS
CONDENSERS • CENTRIFUGAL PUMPS
OIL AND GAS ENGINES

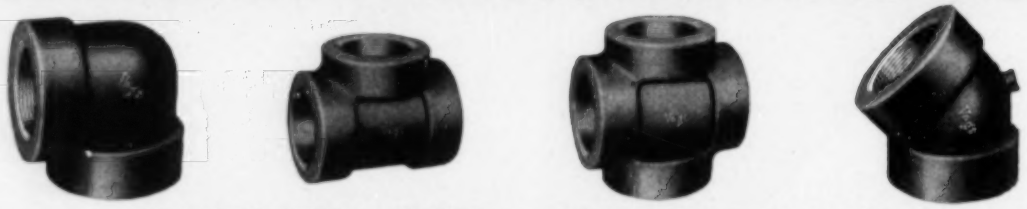
Ingersoll-Rand

11 Broadway, New York 4, N. Y.

184-1

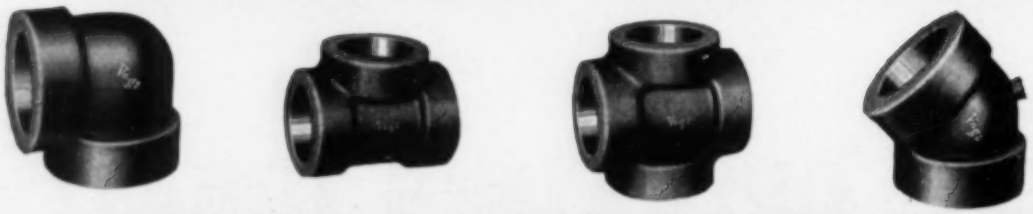
STRENGTH

for Safety and Long-Time Service



For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SCREW END TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 4"

SOCKET WELD TYPE

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

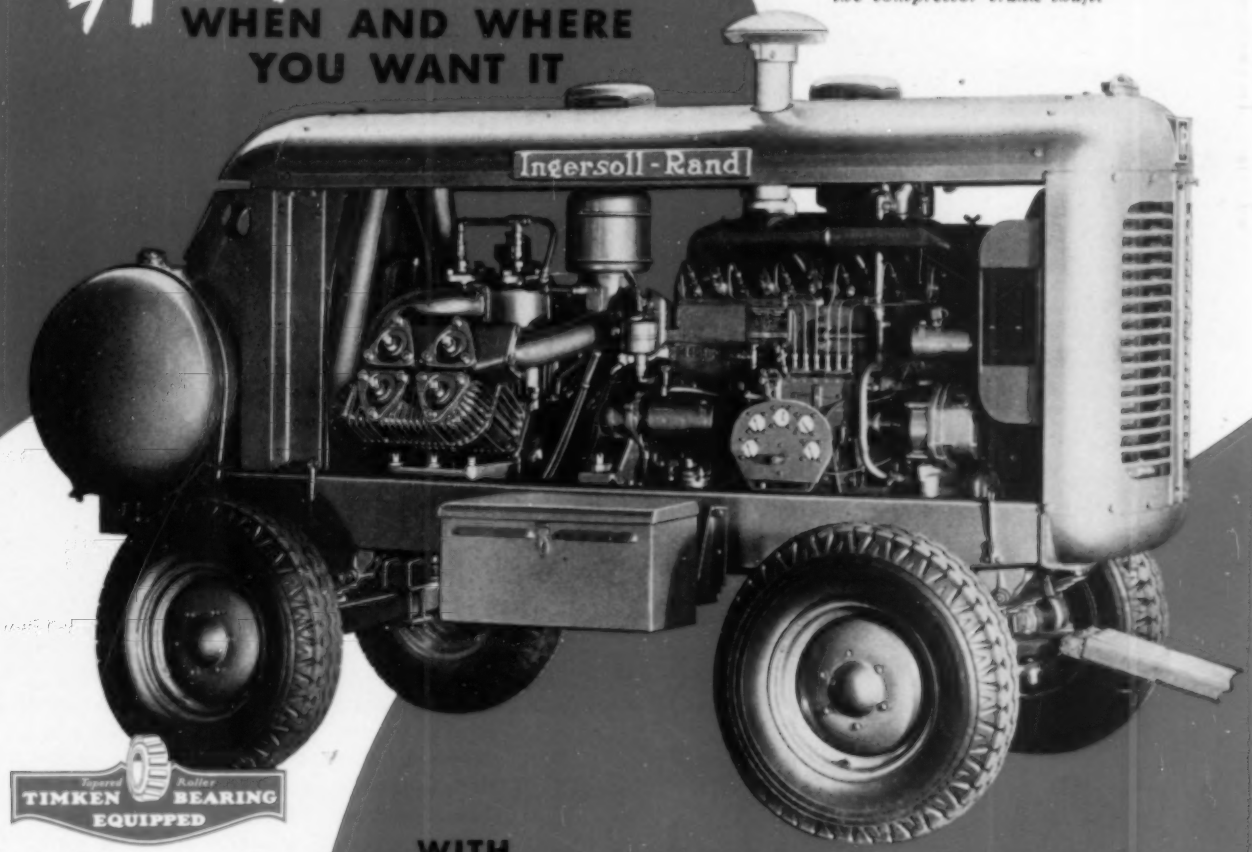
Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy in steam plants, petroleum refineries, chemical plants and related industries.

HENRY VOGT MACHINE CO., INC.
Louisville 10, Kentucky
BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

Vogt DROP FORGED STEEL FITTINGS

Air Power
WHEN AND WHERE YOU WANT IT

Ingersoll-Rand Model HK-500 "Mobil-Air" Compressor equipped with Timken Bearings in the road wheels and on the compressor crank shaft.



Tapered Roller TIMKEN BEARING EQUIPPED

WITH

"Mobil-Air" Compressors

TIMKEN® BEARING EQUIPPED

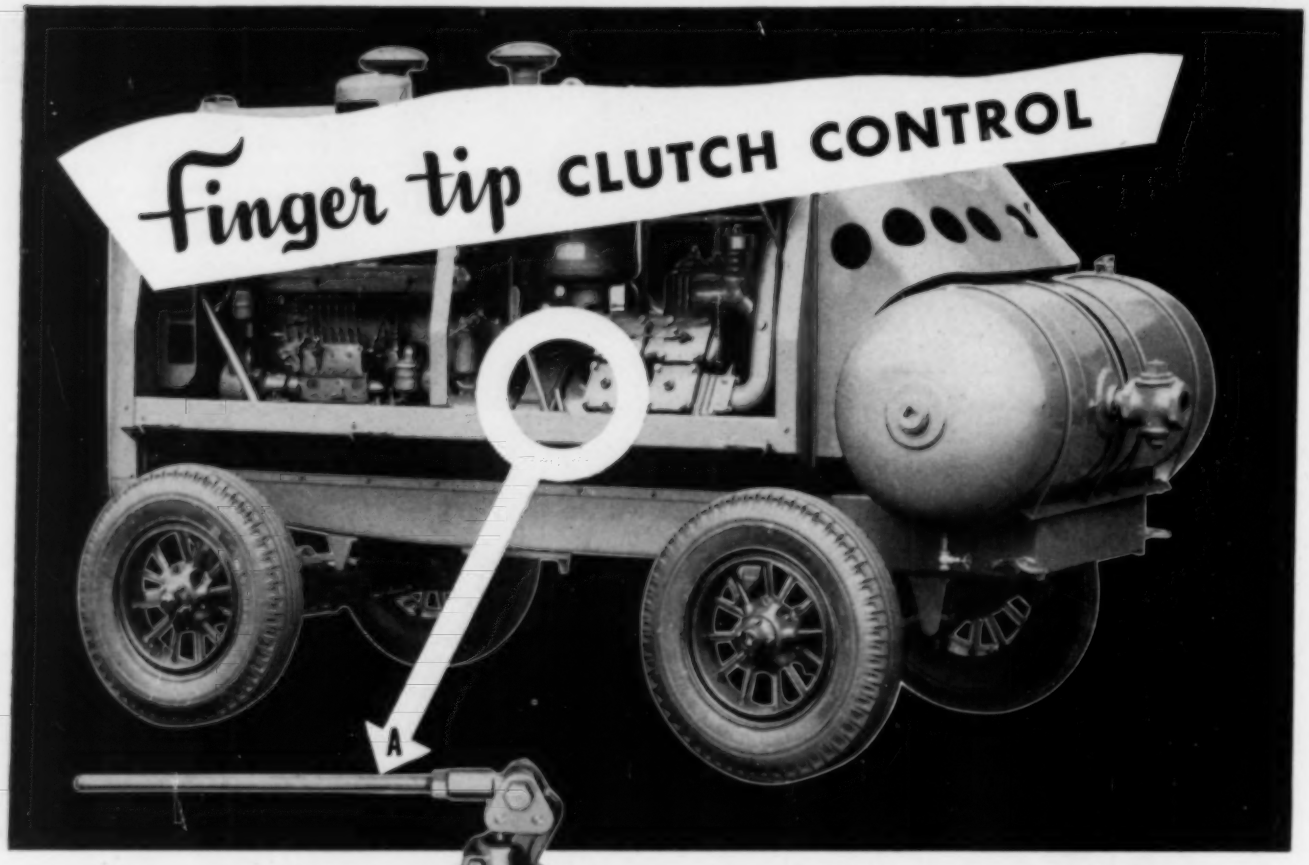
In Ingersoll-Rand "Mobil-Air" portable air compressors Timken Tapered Roller Bearings are used to facilitate easy, rapid movement on the road and to help the compressor itself deliver a constant volume of air at consistently low operating and maintenance cost.

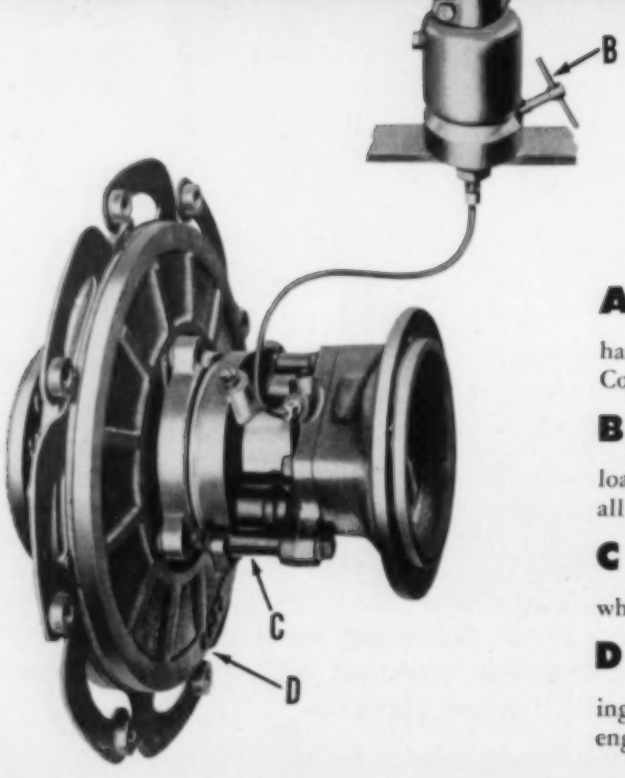
They do this in both cases by eliminating friction; preventing wear; carrying radial, thrust and combined loads; and holding moving parts in correct and constant alignment.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

The Ingersoll-Rand Company has used Timken Bearings in portable and stationary compressors for many years. To make sure of getting the utmost in anti-friction performance and economy when buying any type of compressor be sure it is Timken Bearing Equipped. The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬭ AND THRUST → ⬭ ← LOADS OR ANY COMBINATION





A contributing factor in the top-quality service of the new KA Series of I-R *Mobil-Air* Compressors under all conditions is easy, dependable clutch operation. These portable compressors are equipped with time-tested *Flex-Disc* Clutches now hydraulically controlled.

A The clutch is disengaged by two or three easy strokes of this accessible pump (hydraulic jack) handle shown at left and above in a Model HKA-500 Compressor.

B The clutch is engaged by a slight turn of this valve handle. The operation of the clutch, spring-loaded to 4300 lbs. pressure is easy and reliable under all weather conditions.

C A long and trouble-free service is assured by the dual jacks and ball bearing shift collar which actuate the clutch.

D The *Flex-Disc Clutch* is a dependable, low-upkeep clutch designed so that worn friction facings may be easily replaced without disconnecting engine and compressor.

INDUSTRIAL CLUTCH CORPORATION

Waukesha Wisconsin

MORE AIR POWER FOR CONSTRUCTION...

Compressor With Electric Drive: A High-Efficiency Tool For Progressive Contractors

Compressed air . . . electricity; each has its own field of application in construction operations. And when combined they form an unbeatable team for supplying continuous compressed air at the lowest possible operating cost. The electric drive requires little maintenance, yet affords maximum reliability. If the compressor power requirement is 75 horsepower or more, synchronous motors can be applied which give the additional advantage of power-factor improvement on the line, thereby making possible further savings in operating costs.

ELECTRIFIED CONSTRUCTION
BETTER PRODUCT
LOWER COST

The electrically driven compressor is just one of many electrified construction tools which are helping contractors build more for less . . . faster. Whether you buy or build contractors' equipment, ask your General Electric representative to show you the inherent advantages of electric drive. *Apparatus Dept., General Electric Co., Schenectady, N. Y.*

GENERAL ELECTRIC

655-65

Surface Your Castings Faster and More Economically with NORTON B-5 RESINOID DISCS

YOU'LL find Norton B-5 Resinoid Discs with strong, sharp 37 Crystolon abrasive especially effective for surfacing gray iron and non-ferrous castings—they combine fast, smooth cutting action with exceptionally long life

And Norton discs of free-cutting 57 Alundum abrasive and B-5 Resinoid bond are economical for surfacing steel and annealed malleable iron castings.

Suggested Specifications—

Aluminun Castings	37C20-M5B5 No. 12 Tr.
Brass & Bronze Castings	37C20-M5B5
Gray Iron Castings	37C16-L5B5
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NORTON ABRASIVES

ON THE COVER

MANY persons who find city life rather irksome during the hot-weather months may cast envious eyes on the construction-camp scene on our front cover. It shows the temporary home of one of the tunnel-driving crews engaged on the Pacific Gas & Electric Company's project, which is described in our first article. Despite the limited space available, buildings have been disposed so as to save trees from destruction. Note how the lean-to adjoining the quonset hut at the right has been built around a large conifer, which seems to be growing out of the structure's roof. On the canyon wall in the background are glimpses of two timber flumes long used for carrying water for hydroelectric generation and destined to be replaced by the tunnels now being driven.

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IN THIS ISSUE

THE present shortage of electric power in many sections of the country is especially acute in California owing to a huge influx of people, with an accompanying boom in industrial activity coupled with unusually sparse precipitation. In an effort to overcome the deficiency in the territory it serves, Pacific Gas & Electric Company is pushing a $400,000,000 construction program to improve and expand its hydroelectric generating system. One phase of this activity, involving the building of works to permit more extensive utilization of the flow of the Mokelumne River, is described in our leading article.

•

A FIRMLY rooted belief that the deep South cannot compete with some other sections of the nation in certain kinds of manufacturing has been disproved to a considerable extent through the establishment of branch factories there by various northern concerns. Further evidence that this conception is only a bogy is to be found in the article starting on Page 109. It outlines the policies and methods by which J. Paul Treen has developed the Simplex Manufacturing Corporation of New Orleans, La., into a leading producer of powercycles. His success is the more significant because it grew out of an entirely native and independent effort and because the product is a precision-built machine of a type that has seldom been made profitably in the southern sector.

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SHORT articles include a description of a California highway-striping machine that uses air power in various ways and an account of a compact, dependable pumping system to provide running water for consumers living beyond the limits of city service.

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C. H. VIVIAN, *Editor* J. W. YOUNG, *Director of Advertising*
ANNA M. HOFFMANN, *Associate Editor* J. J. KATARBA, *Advertising Mgr.*
A. W. LOOMIS, *Assistant Editor* JOSEPH C. DILTS, *Advertising Sales*
WALTER P. GILLINGHAM, *Assistant Editor*
D. Y. MARSHALL, *Europe*, 243 Upper Thames St., London, E.C.4.
F. A. McLEAN, *Canada*, New Birks Building, Montreal, Quebec.

EDITORIAL CONTENTS

More Power for the San Francisco Area—*L. A. Luther* 104
Building Servi-Cycles Better and Faster—*C. H. Vivian* 109
Applying Cement Mortar as Dense as Granite 115
Marking Highways for Safety 116
Intricate Equipment Parts Go to Dry Cleaner 119
Jet Pumps for Rural Service—*J. W. McConaghy* 120
Editorials—Modern Highway Building—Our Future Iron 122
Industrial Notes 123
New Book on Pumps 125
Industrial Literature 126

ADVERTISING INDEX

Air Maze 34
Allis-Chalmers 25
American Leather Belting Assn. .. 12
Bethlehem Steel Co. 9, 26
Burgess-Manning Co. 28
Burke Electric Co. 11
Compressed Air Magazine 31
Conrader Co., R. 34
Cook Mfg. Co., C. Lee 24
Crane Co. 27
Cuno Engineering Corp. 19
Dollinger Corp. 3
Eimco Corp., The 7, 33
Fluor Corporation, Ltd., The 40
Galland-Henning Mfg. Co. 30
General Electric Co. 17, 39
Hercules Powder Co. 32
Hose Accessories Co. 38
Houghton & Co., E. F. 29
Industrial Clutch Corp. 16
Ingersoll-Rand Co. 13, 36, 37
2nd Cover
Lake Shore Engineering Co. 22
Madesco Tackle Block Co. 35
Maxim Silencer Co., The 28
Naylor Pipe Co. 21
New Jersey Meter Co. 30
Nicholson & Co., W. H. 35
Norgren Co., C. A. 38
Norton Co. 18
Punch-Lok Co. 35
Raybestos-Manhattan, Inc., ... 8
Rhoads & Sons, J. E. ..... 3rd Cover
Saval Co. 28
Schieren Co., Chas. A. 31
Square D Co. 34
Terry Steam Turbine Co., The .. 10
Texas Co., The ..... 4th Cover
Timken Roller Bearing Co., The . 15
Victaulic Co. of America 20
Vogt Machine Co., Inc., Henry .. 14
Wagner Electric Co. 23
Walworth Co. 6
Westinghouse Electric Corp. .. 4, 5
Wisconsin Motor Corp. 38

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More Power for the San Francisco Area

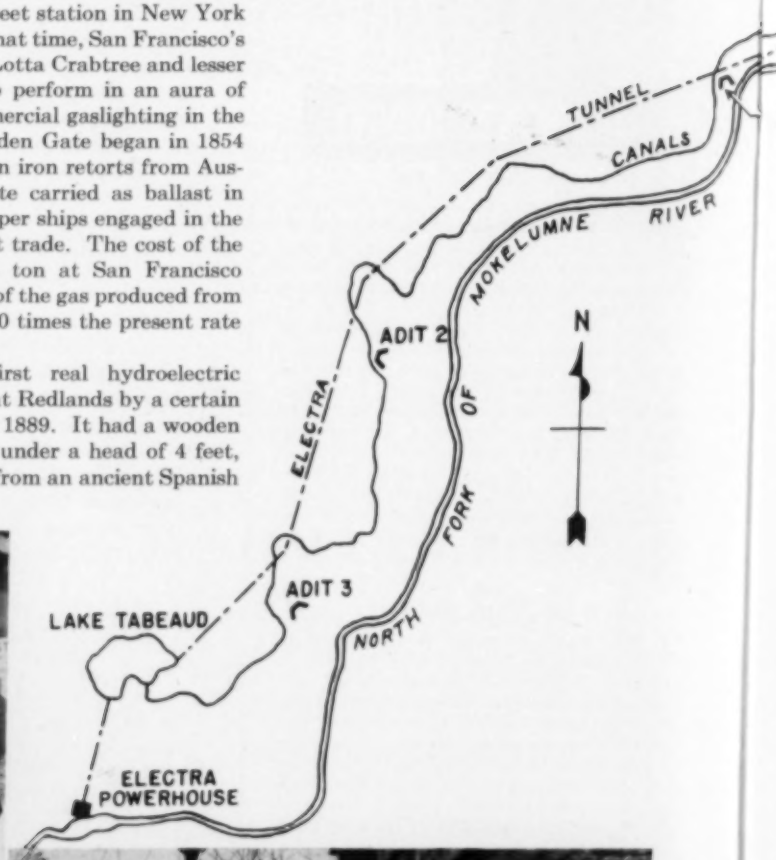
L. A. Luther

THE current acute drought in California serves as a reminder of the state's dependence on runoff from its Sierra watersheds not only for irrigation and urban water supply but for power to turn the wheels of industry. The Pacific Gas & Electric Company, a public utility serving the San Francisco Bay area and much of northern and central California with electric power and gas for domestic and industrial use, is engaged in a $400,000,000 building program which is to extend over a 6-year period and will add 1,400,000 hp. to the company's hydroelectric generating capacity by 1951. This will bring the total horsepower available to the utility to nearly four million.

The two largest elements in this project are a 43,000-foot tunnel, the longest of two to be driven, and a new 133,000-hp. power plant. Both carry the name Electra, and the powerhouse will replace an older station, also called Electra. All are the outgrowth of a hydraulic enterprise that dates back to 1855 when placer mining began to flourish in the newly created state. In that year, ambitious miners of Slabtown and Butte City built 19½ miles of ditches at a cost of $75,000 to operate placers south of the town of Jackson. Their corporate holdings, like those of some 450 other companies engaged in a variety of undertakings, eventually became part of the Pacific Gas & Electric family tree.

San Francisco claims to have given birth to one of these enterprises with the construction in 1879 of a steam-powered central station at Fourth and Market streets. Supposedly the first of its kind in the United States for the commercial production of current for lighting by means of arc lamps, it antedated by more than a year Thomas A. Edison's famed Pearl Street station in New York City. Prior to that time, San Francisco's beloved singer Lotta Crabtree and lesser troupers had to perform in an aura of gaslight. Commercial gaslighting in the City of the Golden Gate began in 1854 with gas made in iron retorts from Australian anthracite carried as ballast in the holds of clipper ships engaged in the California wheat trade. The cost of the coal was $40 a ton at San Francisco docks, and that of the gas produced from it was roughly 60 times the present rate in the bay area.

California's first real hydroelectric plant was built at Redlands by a certain Albert Osbun in 1889. It had a wooden wheel, operated under a head of 4 feet, and drew water from an ancient Spanish

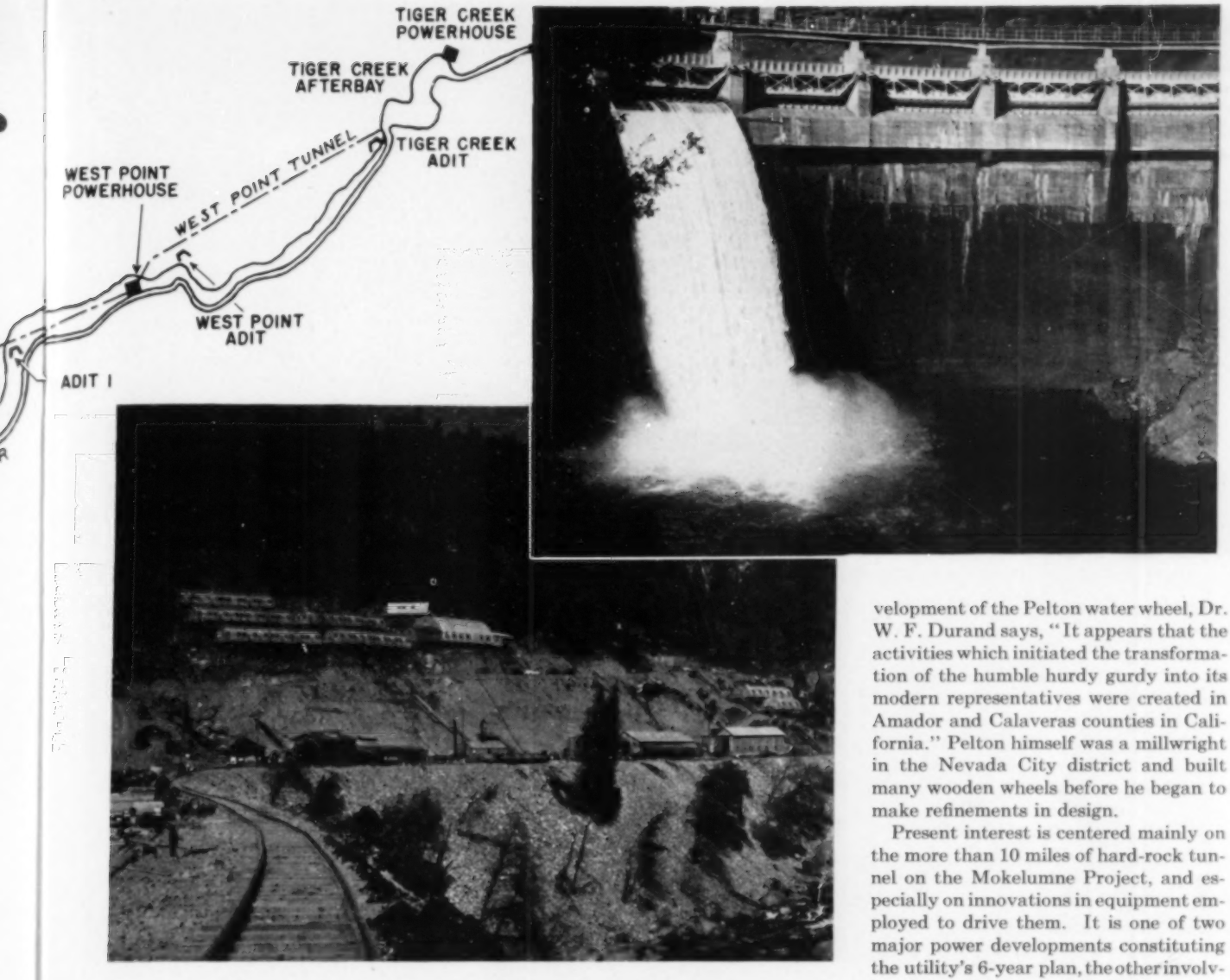


FIGURES IN FAMILY "FEUD"

The end members of this trio both belong to the Huntington family but are rival tunnel drivers on this job. "Les," tunnel superintendent for the Walsh Construction Company, is on the right, and his nephew "Al," of Morrison-Knudsen Company, Inc., is on the left. Between them is Allen Lee of Morrison-Knudsen.

MOTHER-LODE GHOST TOWN

Although Jackson is bursting at the seams and its narrow streets are congested with traffic, the perhaps more famous old mother-lode town of Volcano close by is well-nigh deserted. Among the incidents associated with its past was a near war between slavery and antislavery factions.



TUNNEL LINE, CAMP, AND EXISTING STRUCTURE

The map indicates the course of the Electra and West Point tunnels, with a combined length of nearly 11 miles, and of the old canal-and-flume system which they will replace. In addition, a new Electra Powerhouse will be built with a generating capacity of 133,000 hp. The locations of the various adits through which tunneling operations are being conducted are marked. Electra Powerhouse is only a few miles from Jackson and nearby Sutter Creek, where the initial California gold discovery was made. The lower picture shows the camp near Adit 1 that is occupied by the Walsh Construction Company forces. Because of the steep terrain, the fronts of the buildings are supported on stilts. A section of the afterbay of the Tiger Creek Powerhouse at the upper end of the project is seen in the upper view.

zanja, a canal dug by the mission padres to carry irrigating water from Mill Creek to what later became the great citrus belt. Eight lamps, including one in the local railway station, were supplied with current, and the charge for illumination until ten-thirty each evening was a dollar per light per month.

Pacific Gas & Electric's 27,000-hp. Electra powerhouse that is now giving way to a new plant was the first hydroelectric installation to generate current for San Francisco. The pioneer station and a transmission line of unprecedented length for that era were financed and constructed half a century ago by Prince Andre Poniatowski, a Polish nobleman related through marriage with the banking Crockers of San Francisco. The prince first explored the mother lode for mining properties, and then decided to become an electric-power tycoon. His plant is still functioning.

The mother-lode area in which the original Electra station stands has made notable contributions to the science of hydraulics, for there men witnessed the earliest attemps at hydraulicking. The monitors used were invented by enterprising miners to save the labor of shoveling gravel into their sluice boxes and were suplied with water under pressure delivered by rawhide hose lines. In his historic sketch on the genesis and development of the Pelton water wheel, Dr. W. F. Durand says, "It appears that the activities which initiated the transformation of the humble hurdy gurdy into its modern representatives were created in Amador and Calaveras counties in California." Pelton himself was a millwright in the Nevada City district and built many wooden wheels before he began to make refinements in design.

Present interest is centered mainly on the more than 10 miles of hard-rock tunnel on the Mokelumne Project, and especially on innovations in equipment employed to drive them. It is one of two major power developments constituting the utility's 6-year plan, the other involving the expansion of facilities on the Feather River. Conduits that now carry water to hydroelectric plants located in the canyon of the Mokelumne and that are to be replaced by two sections of new tunnel consist largely of open ditches and flumes winding along the canyon's north wall, the grades at certain points dating back to gold-rush days.

To be built at a cost of $20,000,000, the undertaking is based on data accumulated for more than half a century and on plans that have been maturing for several years. It was initiated early in 1947 with the construction of access roads and the establishment of six camps to house contractors' forces, a sum of $250,000 being invested in those facilities. The storage capacity of one mountain reservoir is being increased by the installation of a series of radial gates across its spillway. Besides carrying water by more direct routes and in greater volume, the tunnels will be immune to damage by storms and slides; and evaporation, which takes a heavy toll from miles of meandering water in ditch and flume, will be reduced.

AIR POWER AT WORK

Although the principal service of compressed air is the operation of rock drills in driving the tunnels, it also saves time and labor in numerous other ways. These views show a Multi-Vane air drill (below) reaming bolt holes on a penstock section, a No. 73 clay digger (left) excavating a penstock footing in shale, and a Size 500 cutoff wheel cutting drill steel.

The Electra Powerhouse is located at the lower and western end of the project. It is a 230x54-foot concrete structure which, including the 166x33-foot control building with essential machinery and accessories, represents an outlay of more than $15,000,000. Its three generators will have an aggregate capacity of 99,000 kva., and their turbines will produce a total of 133,000 hp. The buildings at this site and an afterbay dam are in place, having been constructed under contract by Morrison-Knudsen Company, Inc. At present, 3350 feet of steel penstock, tapering downward from a diameter of 10 feet to 7½ feet, is being trucked in and assembled on concrete footings by the Western Pipe & Steel Company. This conduit will deliver water to the turbines under a 1200-foot head.

Lake Tabeaud, the forebay reservoir, will serve the penstock as it has the old plant soon to be retired. Some 2900 feet of tunnel connects the lake with old penstocks and will also convey water to the new penstock. This tunnel is being enlarged to 12-foot diameter by the Utah Construction Company under a contract that includes driving the lower and western end of the 43,000-foot Electra Tunnel. This 12x15½-foot horseshoe-shaped bore will serve as a conduit between Lake Tabeaud and West Point Powerhouse, a smaller plant at a higher elevation that will house one 16,000-kva. generator. The concrete structure is being built by Utah forces.

The Electra Tunnel is being excavated under three contracts. Work on the section awarded to the Utah Construction Company is progressing from two headings, one above and one below its camp at Adit No. 3; Morrison-Knudsen is driving the adjoining stretch from two working faces advancing in opposite directions from its camp at Adit No. 2; and the third contract was let to Walsh Construction Company which is camped near the upper tunnel portal at Adit No. 1. From that point, the latter is now pushing one heading in a southwesterly direction, while a second, that was driven northeastward, has been holed through.

Another tunnel, 14,000 feet long and likewise 12x15½ feet in section, will connect the West Point Powerhouse and the afterbay of the Tiger Creek station—a larger, existing plant farther upstream. The contract for the so-called West Point Tunnel and for a 30-foot surge chamber 200 feet from its lower portal is held by T. E. Connolly, Inc. The latter maintains two camps. One is at the West Point Adit from which a heading is being advanced to meet a second being driven from the Tiger Creek Adit near the eastern end of the Mokelumne Project, where the second camp is located. A section of 2400 feet of tunnel between the surge chamber and West Point Adit has been completed.

Rock penetrated to date in both tunnels has been predominantly granite, which has varied widely in structure and hardness. Some granitic diorite has been found, with limited zones of true diorite. No large water pockets or extensive faulted or shattered areas have been encountered so far in the West Point Tunnel, and the formation there has been more uniform than that in Electra. Only short sections have needed timbering, and the prospects are that no

GOING THROUGH BAD GROUND

Timber supports erected by the Morrison-Knudsen forces in a stretch of unstable rock. Because of water pockets and heavy, swelling ground encountered in the Electra Tunnel, the company may have to line 20 percent of its section with concrete. DA35 drifters are mounted on the drill carriage in the foreground.

extensive concrete lining will be required. In the case of the Electra Tunnel, the workers have struck water pockets with temporary flows of perhaps 600 gpm. Zones of heavy ground and of swelling ground, in which seams of schist have occasionally figured, were encountered in this bore.

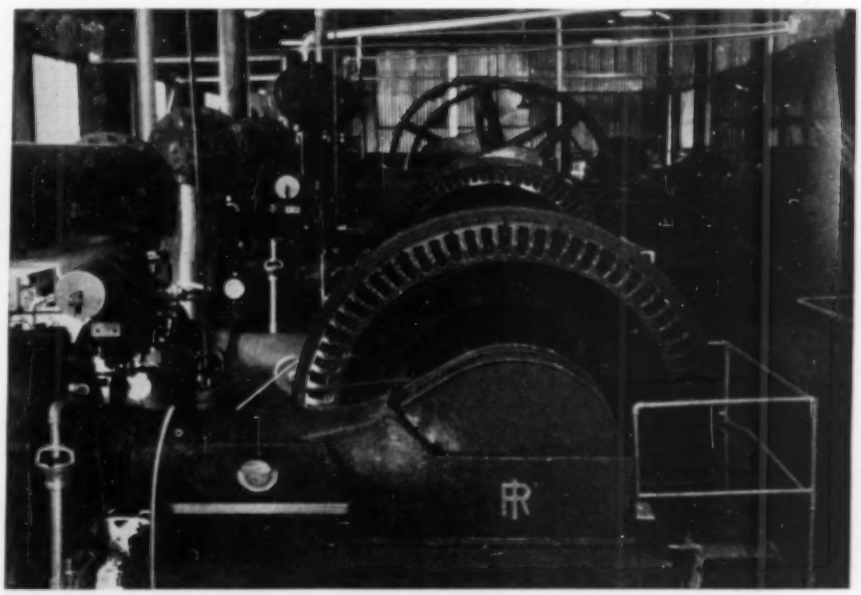
Morrison-Knudsen estimates that perhaps 20 percent of its contract may necessitate timbering and lining with concrete. Timber sets generally employed are 10x10's and 10x12's on 4-foot centers. One 200-foot zone of swelling ground penetrated by its forces could not be held by timbers. A timber-changing technique was therefore developed which made it possible to assemble grilles or cages of interlaced reinforcing steel to retain and stabilize 18-inch-thick rings of quick-setting concrete. In this manner, headings were sometimes advanced by the bench method, using a bulkhead.

Because tunnel driving has become a more or less conventionalized procedure, and because the formation in the Electra and West Point tunnels is relatively uniform and the section throughout is the same, there is a marked similarity in equipment and methods on the four contracts. Battery locomotives on track of uniform gauge do the hauling; drills are mounted on jumbos with hinged working platforms; and mucking and ventilating facilities are much alike, if not identical. Where tunnel sections have to be lined, the concrete will be placed in steel forms by means of air-operated guns. Electric current for driving the compressors and other equipment has been made available at all camps by the utility.

Drifters on the various jobs range in size from 3 to 4 inches, and all are provided with some type of mechanical feed. The use of jumbo-mounted drills as small as 3 inches is unusual in excavating hard rock in the volume handled, and a further innovation is the utilization by Connolly of small-diameter (1½-inch) Carset bits. The cutting faces of this bit consist of Carboloy (tungsten carbide) inserts secured in slots in the steel bit, which is attached to a 1⅛-inch, round, alloy-steel drill rod by a threaded stud of special alloy steel. The end of the stud that goes into the rod is deeply furrowed and cone-shaped to lock it in place. The stud is driven cold into the heated end of the rod, work that is readily done on a drill-steel sharpener.

Because of their greater durability as compared with detachable bits of the conventional type, it has been found that one Carset bit will collar and finish several holes before it needs reconditioning. Also, lighter drill rods with their reduced impact-absorbing inertia, combined with smaller-diameter bits, are enabling the fast-hitting 3-inch drifters to outdrill even 4-inch machines when the latter are equipped with bits of the usual size.

Contractors on the Mokelumne Project that are not using the new bit have coöperated in making comparative test runs over extended periods by mounting a 3-inch drifter on their jumbos in place of one of their regular 4-inch drills, the former being provided with a 1½-inch Carset bit and the latter with conven-



ONE OF THE COMPRESSOR SHOPS

These Ingersoll-Rand machines are stationed at the Morrison-Knudsen camp, Adit No. 2. They were once in service at the Kennedy Mine in the nearby mother-lode mining district.

tional steel. In putting in ten of the 60 holes constituting a round, the lighter machine finished, on an average, two holes ahead of the other drill. Workers naturally prefer the lighter drifter, and there is a slight saving in set-up time. Furthermore, the 4-inch machine consumes about 220 cfm. of air, or 30 percent more than the 3-inch.

After Connolly adopted Carset bits, two men working one shift were able to maintain drill rods and bits for 3-shift operation at both headings, whereas a blacksmith and helper were formerly kept busy on the job through each of the three shifts. The smaller-size steel and fewer changes required at each face have eliminated one of the two nippers that were previously needed per heading per shift. The contractor has used 45 percent explosive in loading the 5- and 6-foot rounds fired, and the granite formation has broken satisfactorily with 10 percent less powder than was required when the holes were larger.

Connolly has made it a practice to use Carset bits a prescribed number of rounds. At the end of that period all are removed from the rods, inspected, and, if necessary, hand-sharpened, some being dressed as many as four times. Then the bits and rods are reassembled and returned to the heading. Proper reconditioning of Carset bits is a bigger factor in obtaining maximum economy, as represented by footage drilled per bit, than it is in the case of regular drill steel or bits. Through the courtesy of the Walsh Construction Company, ten bits were recently run at its Electra heading until they had to be discarded. The result of that test was an average of 288 feet of hole per bit.

One of the generating units of the new Electra power plant is scheduled to be ready for use in June, and the end of the year should see the work virtually completed. Pacific Gas & Electric Company has field offices at Martel near Jackson, which is approximately 7.5 miles west of the Electra Power House site. Jack E. Cooney is general superintendent of hydroelectric construction and George B. Thatcher is resident engineer on the Mokelumne Project. Ben Arp is general superintendent and Fred Arp tunnel superintendent for the Utah Construction Company; Tom Ayers is chief engineer for Morrison-Knudsen Company, Inc., with F. A. Huntington as general superintendent; E. H. Hatch is project manager for Walsh Construction Company and L. E. Huntington is tunnel superintendent; J. N. Barnett is project manager for T. E. Connolly, Inc., with Martin Johnson as tunnel superintendent at the West Point Adit and Ted Straight tunnel superintendent at the Tiger Creek Adit.

PLACING ELECTRA PENSTOCK

At the top-right is a length of penstock about to take a ride up the mountain to be joined to the assembled members left of it. A view of the penstock from above is at the left. After a section has been hauled up the inclined railroad by a line from a hoist stationed at the mountain top, it is pulled off the car by a Caterpillar tractor. Then a cable that passes through a sheave anchored to the track is run around the big piece of pipe, permitting an air hoist (man at right) to roll it into place. At the top of the picture, parallel with the railroad, is the new Electra Powerhouse. Right of it is the pioneer California station that furnished San Francisco's first hydroelectric power. A close-up of the HU air hoist that positions the penstock sections is at the top-left.

Building Servi-Cycles Better and Faster

Small Aircraft-Type Pneumatic Tools Help New Orleans Firm Disprove Tradition that South is Unfavorable Place to Build Precision Machinery

C. H. Vivian

TYPICAL SERVI-CYCLE RIDERS

Servi-Cycles equipped with box trailers are used for parcel deliveries by Western Union and tradesmen in many cities. Dean P. Sims (top), on the lawn in front of the Servi-Cycle plant in New Orleans, La., decided upon his discharge from the Navy at Long Beach, Calif., to see some of the country. He purchased a Servi-Cycle and started for his home in Detroit, Mich., by way of New Orleans and Miami, Fla., a distance of some 5000 miles. For the 2663 miles to New Orleans, his fuel and repair expenses were less than one cent a mile.

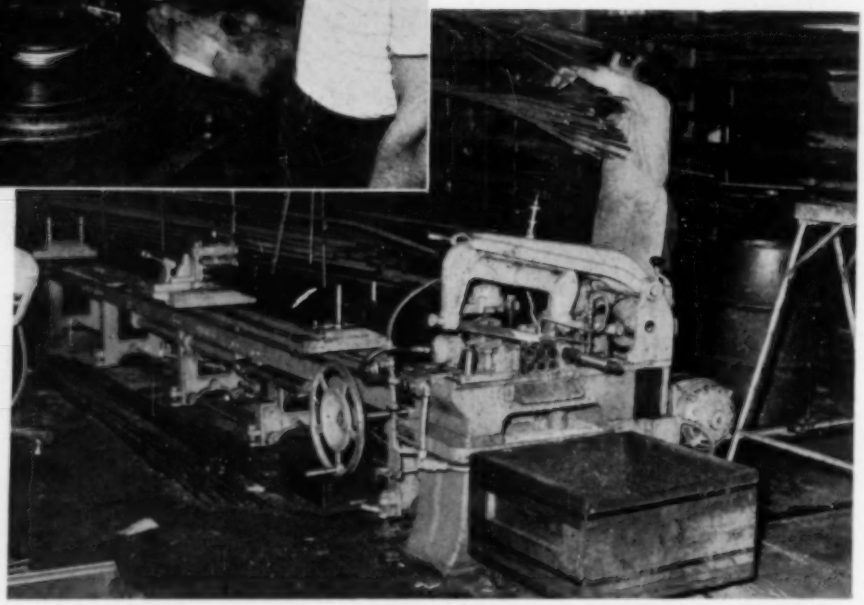
TWENTY-ODD years ago, while operating several motorcycle sales agencies in Louisiana, J. Paul Treen got the idea that a lightweight powercycle would find a market in America. He began working on such a machine, and by 1927 had designed the first model of the Servi-Cycle which is now being manufactured in New Orleans by the Simplex Manufacturing Corporation, which he heads. The Servi-Cycle is a 140-pound, 2-wheeled machine that offers dependable transportation for one person at a maximum speed of 35 miles per hour and sells for $249.50 anywhere in the United States. It will travel 100 miles on one gallon of gasoline.

Machines of this type have been popular for some years in Europe because comparatively few people there have the means either to buy automobiles or to run them at the price they must pay for gasoline. It is only recently, however, that they have come into favor in the United States, and even now Servi-Cycle's chief competition is offered by foreign machines. It sells here for $100 and some less than a comparable British-made model, on which there is only about $20 import duty.

This price difference is somewhat remarkable for several reasons. First, the American men who build Servi-Cycles are not only paid much more than their British cousins but also enjoy working conditions and benefits that are virtually unknown abroad and are found in few factories even in this country. These obviously increase overhead expense. For instance, the plant is entirely air conditioned the year round at a cost of approximately $100 annually per employee. Second, Servi-Cycles are made in the deep South, which is supposedly an unfavorable location for manufacturing an article of this type primarily because southern labor has traditionally been considered less efficient than that in the North. The experience of the Simplex concern does not support this theory.

The Simplex success story is a southern version of a familiar American industrial theme. It has again proved that a combination of modern plant layout and machinery, intelligent product design, carefully planned techniques, and a demonstrated interest of management in worker welfare pays off. With such coordination, it seems to make little difference on what side of the Mason-Dixon Line a factory is located.

Mr. Treen began making a few machines a week in a small shop. Production increased year by year, and the design was meanwhile improved progressively. World War II gave the business a boost, as the armed services found that they could use powercycles to advantage. The Servi-Cycle was supplied mainly to Army paratroop units. It was light enough to be dropped from an airplane by a 1-man parachute and provided immediate ground transport for landing, airborne troops. The machines served many training bases in this country and accompanied invasion units to Africa, Italy, Sicily, and elsewhere in

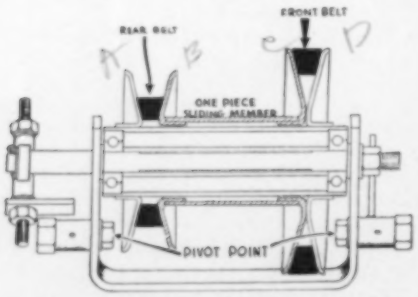


TWO SHOP MACHINES

The Racine multiple saw (below) can be loaded with up to 20-foot lengths of rods or tubing and will automatically saw the material into any desired pieces from 1 inch to 1 foot long. Hydraulic clamps at the side and top release after a cut has been completed, and the material is then pushed forward the distance for which a gauge has been set. The machine is set to saw six pieces of $1^{9}/_{16}$-inch tubing for clutch-spacing members. The other picture shows the fixture on which pieces of tubing for the Servi-Cycle frame are bent to accurate contours preparatory to welding them into an integral assembly.

Europe. Civilian sales during the war were subject to priority control, the same as automobiles. Since the end of the conflict, the number of powercycles in use has increased rapidly.

The International Powercycle Association classifies a powercycle as a machine weighing not more than 175 pounds and having a maximum speed of 35 miles an hour. In addition to such units as the Servi-Cycle which have a power plant built into them, the category includes bicycles with power attachments, lightweight "Scooters," and the like. It does not embrace motorcycles, some of which weigh 600 to 700 pounds and sell for as much as $1000. Three states, Louisiana, Wisconsin, and California, have sections in their motor-vehicle laws pertaining to the licensing of powercycles, and others will likely follow suit.



VARIABLE CLUTCH

Section through the Servi-Cycle countershaft, showing how the pulley openings can be varied by a sliding member to change the ratio of power transmission. In this low-gear view, the front belt that extends to the engine flywheel shaft is riding high in its pulley groove, while the belt that runs to the rear drive wheel is at the bottom of its pulley groove. Operation of the shift pedal serves to slide the inner faces of the two pulleys simultaneously. When in high gear, the left belt rides at the top of its groove and the right one is seated at the bottom of its groove.

Before the war there were only about 25,000 machines of that type in the United States. Now there are around 300,000. Naturally, they are most numerous in places where they can be ridden the year round, and they are common sights on the streets of New Orleans. They are spreading northward, however, and 500 Servi-Cycles were sold during the past winter in Canada, although the factory wasn't informed as to the use that was to be made of them. They are distributed through dealers located in every state of the union. There are more than 1000 of them, and many also handle bicycles, some sell outboard motors, while others deal only in Servi-Cycles. All these representatives carry stocks of repair parts and are equipped to service the machines they sell.

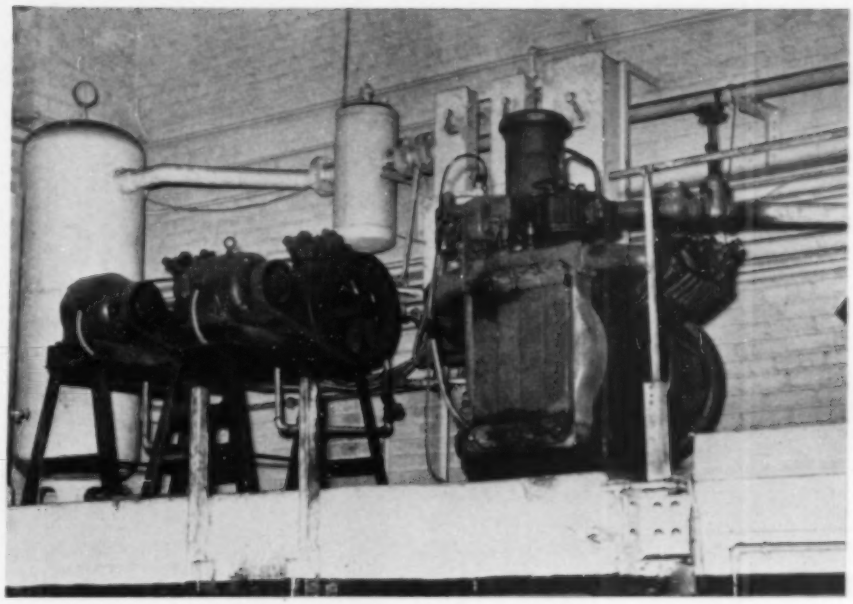
In the early years of their production, most Servi-Cycles were used by juveniles for pleasure riding. Since the war, however, the scarcity and mounting cost of automobiles, together with steadily rising gasoline prices, have tended to increase the demand for machines for utilitarian purposes. A check by the company on those sold during two months of the past winter shows that only 16.5 percent of them was purchased strictly for pleasure riding. The largest group of buyers—29.6 percent—intended to use them for going to and from work. Seven out of every ten of the latter were more than eighteen years old. In second place was the 26.7 percent purchased for making deliveries by Western Union messengers, paper carriers, drug and grocery stores, and other concerns. Servi-Cycles for such purposes are often equipped with a 2-wheeled box trailer. Owners of 15.4 percent of the machines bought them primarily to ride to and from school, and eight out of every ten in this class were more than eighteen years of age. Others listed were to be used for collection work, patrol duty, bank-messenger service, and for pickup-and-delivery service by filling stations and automobile dealers.

Although the maximum speed is 35 miles an hour, experience has proved that a Servi-Cycle will ordinarily make better time in city traffic than an automobile. This is because it can thread its way through lines of vehicles with facility. For example, a rider can move alongside a string of cars stopped for a traffic

signal and be first away when the light changes.

By 1943, the growth of the business necessitated larger quarters, and Simplex acquired the compact 1-story structure with 50,000 square feet of floor space that now houses the enterprise. There are no stairways to climb, and one has only to open a door to go from offices to factory, or *vice versa*. Successive manufacturing operations follow the shortest lines of flow, starting in the machine shop and continuing to the final assembly stands. Overhead conveyor systems are used wherever feasible, reducing floor congestion and confusion.

Air conditioning of the plant was not decided on for any manufacturing reason such as there is in some factories where temperature and humidity affect the processes involved. Instead, it was carried out solely to make working conditions more comfortable on the theory that it would give employees a better attitude toward their jobs, reduce fatigue, and thereby increase production. Mr. Treen believes it has accomplished these ends. Air conditioning, however, is just one phase of a studied employee-welfare program.

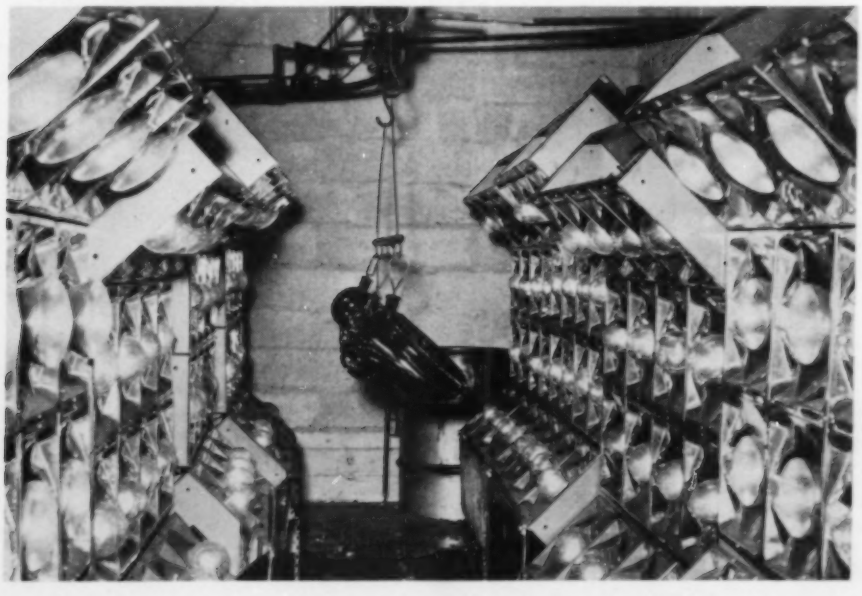


COMPRESSED-AIR SUPPLY

The 25-hp. air-cooled "Motorcompressor" at the right supplies plant air. Two smaller units (left) that were formerly used now serve as standbys. In the background is an aftercooler. The air receiver is at the extreme left.

For 10-minute periods at half-hour intervals during the day music is broadcast. It comes in over telephone wires from a New Orleans studio and is selected each month in advance by a New York firm that has made a study of occupational music. The playing is not loud enough to interfere with conversation, and outlets are spaced so that there is one near every workman. The same circuit serves as a public address system over which the telephone-switchboard operator can page anyone in the plant. Company officials report that the music is popular. No employee has ever complained that it distracts his mind from his work, but if the broadcast is skipped for any reason, or reception is faulty, reports quickly reach the front office. C. P. Flournoy, Simplex personnel director, states that while there is no way of definitely measuring its effect, it is believed that the music stimulates production by improving worker morale.

Another step taken for the workers' benefit was the painting of the entire factory interior in accordance with recommendations by industrial psychological authorities. All employees get two weeks vacation annually with pay, and it is also a company policy to pay the highest wages in New Orleans in its respective job classifications.



INFRARED DRYING TUNNEL

Gasoline tanks that have just been spray-enameled are shown traveling on an overhead conveyor between opposed banks of heat lamps. Lamp reflectors are gold-plated. The conveyor speed is varied in accordance with the part to be dried, the maximum time required being about eight minutes. Gasoline tanks are received in halves, then welded together with a plate in the center. When the fuel on the side connected to the carburetor is exhausted, tipping the powercycle permits a reserve supply of half a gallon to flow in from the chamber on the opposite side of the plate.

The Servi-Cycle has a double, tubular steel frame with single, curved lateral extensions just back of the front wheel to protect the rider's legs in case of a collision or fall. The wheels are of standard-bicycle diameter and take bicycle tires; but the spokes, rims, and hubs are considerably heavier than those of a bicycle. The machine is powered by a single-cylinder, 2-cycle, air-cooled engine of 2-inch bore and 2½-inch stroke that develops about 2.3 hp. at 3000 rpm. In general it is similar to outboard boat-propulsion units and, as in their case, the recommended fuel is "white" or unleaded gasoline mixed with lubricating oil.

Power is transmitted from the engine to the rear drive wheel through two laminated rayon-and-rubber V-belts, without the use of gears. The central and controlling clutch element is a tubular countershaft with a pulley at each end. From one of these pulleys the primary or front belt extends to a pulley on the engine flywheel shaft; from the other, a

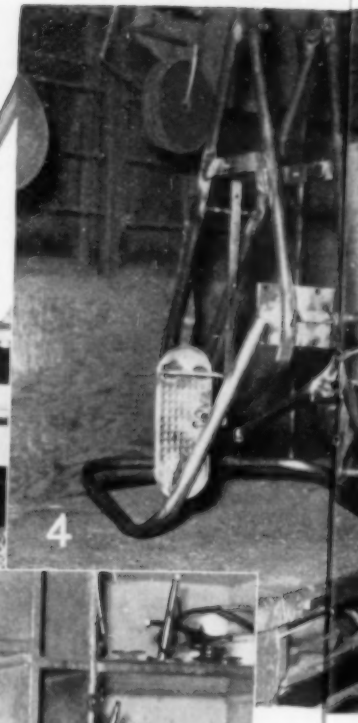
second or final-drive belt extends to a pulley on the rear-wheel axle. The grooves of the clutch pulleys are V-shaped in section and their outer faces are stationary. The inner faces, however, are movable and respond to the operation of the shift pedal. The clutch pulleys are mounted at opposite ends of a sliding tubular member on the countershaft, and as the opening in one becomes larger, that in the opposing one narrows correspondingly.

When in the neutral position, the front belt is slack and no power is transmitted. Depressing the shift pedal makes the inner faces slide over, thus serving to take up slack in the primary belt and causing it to engage the engine pulley. In this starting position the primary belt rides at the top of its pulley groove, the inward-sloping sides of which are then closed at the bottom. The final-drive pulley, on the other hand, is open to its full extent and its belt rides at the bottom of the groove, thereby establishing a low-gear ratio. Further gradual depression of the shift pedal widens the opening in the primary-belt pulley and at the same time narrows the groove in the pulley at the other end of the shaft. Thus the radius of the belt path of the first pulley is reduced and that of the second one is increased. When the shift pedal is fully depressed, the primary belt rides at the bottom of its pulley groove and the drive belt has been forced to the top of its groove. The machine is then in high gear and the ratio of engine-pulley turns to rear axle-pulley turns is at the point at which the Servi-Cycle attains maximum speed. This variable-clutch arrangement obviously makes it possible to vary the power in an infinite number of steps throughout the range of the engine's capacity.

The transmission system not only operates effectively but also is considered the safest so far devised for such a machine. When it is necessary to stop suddenly, the drive belts will slip if the brake is applied forcefully. It is therefore not necessary to shift the clutch in order to overcome the inertia of the engine that, in some other types of transmission, tends to keep a machine moving forward until gears are shifted to place the clutch in neutral position. This feature of the Servi-Cycle is said to lessen accidents in traffic and is deemed especially important in the case of juvenile riders.

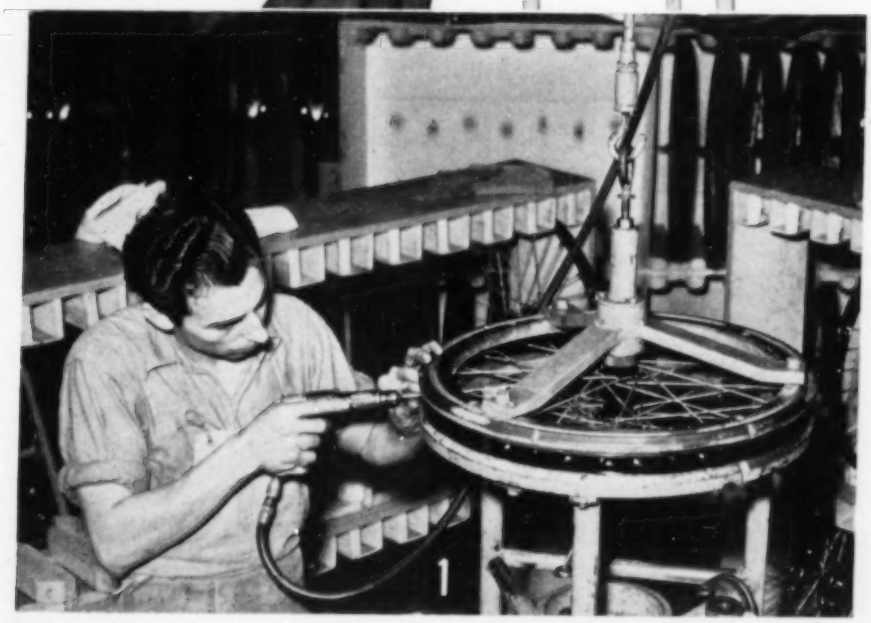
The machine has four controls all of which are operated one at a time by the hands and feet of the rider. A twist of the grip on the right handle bar actuates the throttle. Similarly turning the left grip releases the engine compression when stopping. The brake pedal is operated by the right foot and the clutch pedal by the left foot. The engine is started by means of a "kick" lever on the right side.

The Servi-Cycle is built in four models. The basic one is mostly finished in black enamel; the others include chrome plating of many parts and various refinements and accessories. Although Simplex buys some parts fully assembled—among them lamps, magneto, and carburetor, the machine on the whole is manufactured in its own plant. Parts of engines, tubular chassis, gasoline tanks, clutches, wheels, and other components are made in the rear of the factory and are then fabricated at some 20-odd stations. These subassemblies are next brought together and leave four final-assembly stands as finished products.



Methods of performing the various operations involved are always undergoing scrutiny by the engineering and production departments, and changes are continually being made so that individual jobs may be done better or faster. Sometimes this is accomplished by modifying the design of a part; more often by adopting the latest machinery, tools, and techniques available. The tooling department of eight men makes the jigs and fixtures for the various sections and sets them up for use. Although the new plant has been occupied only five years, all but about five of the 30-odd heavy pieces of equipment originally in the machine shop have been replaced by improved units. In some cases the new equipment has been designed and built by the plant's own staff. An example is a machine that turns both ends of a crankpin at once to a tolerance of 1/2000 of an inch. Tubular frame members that have been cut to length and bent to shape are fabricated in the welding shop into a 1-piece chassis in three stages. Special fixtures have been developed that permit turning the work so that all welding can be done from overhead.

In line with this policy of ever seeking better and quicker ways of doing things, the Simplex engineering and production staffs have become decidedly conscious of the capability and adaptability of air power. Some compressed air has been



AIR-TOOL OPERATIONS

Typical applications of small, lightweight aircraft tools that have speeded up hundreds of operations required to assemble Servi-Cycles.

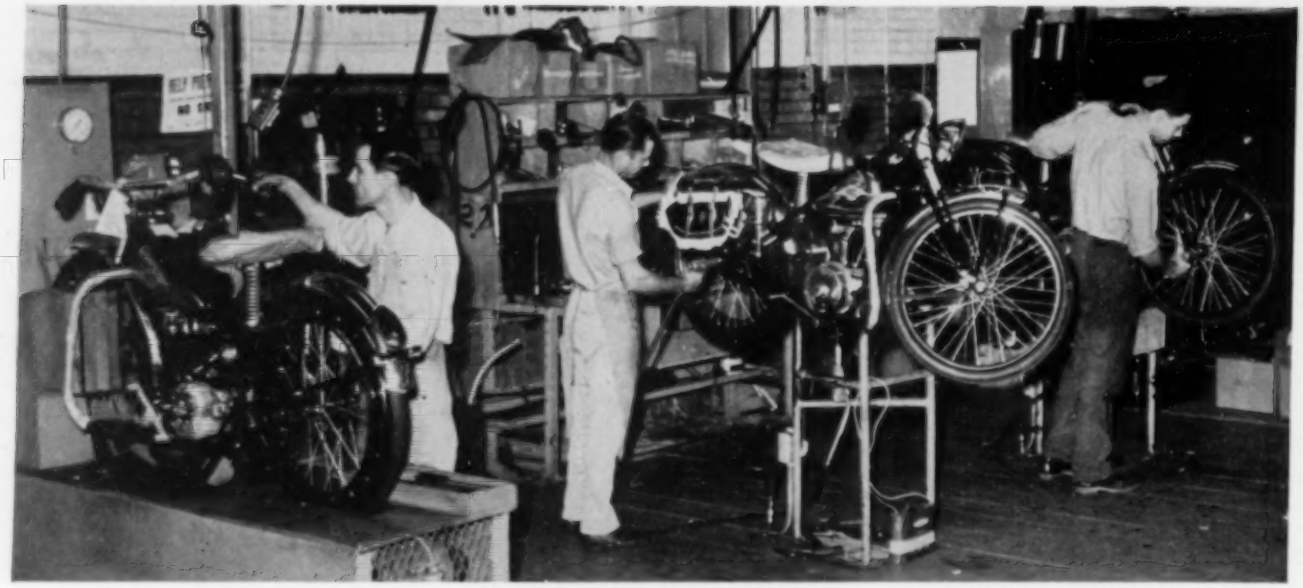
1. Tightening the 36 spokes in a wheel with a pistol-grip pneumatic screw driver. The cycle of mounting a wheel in the fixture, clamping it in three places, tightening the spokes, and removing the wheel, is completed in less than two minutes. Average time for spoke-tightening is approximately one minute. Formerly, when done by hand, the entire operation took more than twenty minutes. Not shown in the picture is an air-cylinder hoist that lifts the wheel on and off the stand.
2. Worker using a straight-handle, air-operated screw driver to put in Phillips-head screws that hold the inspection plate on the motor base.
3. Installing a rocker-arm stud with ¾-inch hexagonal head with a Size 502 impact wrench during the front-fork assembly. Seven operations are carried out with the tool at this subassembly stand, the nut and bolt-head sizes ranging from ⅜ to ¾ inch.
4. Scaling weld surfaces of a frame preparatory to sanding and enameling.
5. Approximately twenty subassemblies are fed to the final assembly stands, one of which is shown here. The operator is putting on a front-wheel retaining nut with an impact wrench. Largely through the use of these small pneumatic tools the final-assembly time has been reduced to an average of 40 minutes per machine.

used for spray painting and other purposes since operations began, but full recognition of its possibilities has come only within the past two or three years. One of the newer turret lathes, equipped with an air chuck and tungsten-carbide cutting tools automatically makes six cuts on a crankshaft. This enables the operator to do other work while the machine is completing its cycle and has reduced the time of performing this job from 12½ minutes to 2⅓ minutes.

There are other auxiliary uses of air, but the outstanding gains in production have been achieved by the adoption of small pneumatic tools for running up nuts and putting in screws. Hundreds of these are required in making the subassemblies and the final assembly, and virtually all this work is now done much faster and easier than was possible previously with hand tools. The first air tools were tried out in 1946 and proved their worth so soon that others were added. By the beginning of 1947 the existing and foreseeable applications of air had increased to such an extent that greater compressor capacity was needed. To provide it, an Ingersoll-Rand 25-hp., air-cooled Motorcompressor was purchased. This unit supplies the plant's current requirements, while two smaller machines formerly in service act as standbys. Additional uses for air tools have brought the number of them to around 35, which is in the ratio of nearly one for every three men in the shop section of the plant. All are small Ingersoll-Rand units of the type that was developed during the war years primarily for aircraft construction.

Of greatest utility at Simplex is the Size 502 impact wrench with a pistol-grip handle and trigger throttle. Torque from the reversible Multi-Vane air motor that runs it is converted into rotary impacts that are transmitted to a socket. This tool weighs only 3 pounds, and the torque reaction is so negligible as to be hardly noticeable by the operator. By using sockets of varying sizes, the 502 can handle almost the entire range of square and hexagonal nuts and studs that enter into the construction of a Servi-Cycle. There is one at every subassembly station. One slightly larger wrench of the same design is available for the relatively few turning jobs that have to be done.

Another aircraft-type tool that has been adapted for a special purpose at the factory is a miniature hammer that was designed for driving aluminum rivets. Designated as the AVC10, this tool is less than 9 inches long and weighs but 3 pounds. It is used by Simplex with a scaling bit for the preliminary cleaning



TESTING AND INSPECTION

The Servi-Cycle at the left is being given a test run on a dynamometer stand equipped with various gauges to show the machine's performance through the full engine-speed range. Any adjustments that may be indicated and a thorough final inspection are made on the stands at the right. Each workman there is using a Size 502 impact wrench.

of welded surfaces on the tubular Servi-Cycle frame. Following scaling, the welds are sanded smooth for enameling.

The third tool in service is a pneumatic screw driver. The heaviest of the two sizes employed weighs 2⅛ pounds, and the other is ¼ pound lighter. Both are less than 10 inches long and have an adjustable cushion clutch that can be set so as to run on all screws to the same degree of tightness. Until forward pressure is applied, the motor runs without the bit turning. This enables the operator to insert the bit in the recess of the screw head and then to exert enough pressure for the clutch to engage, when turning starts. As the motor runs at 1600 rpm., it takes only a second or so to drive a screw.

In many instances, according to J. L. Gale, plant production manager, air tools have cut in half the time formerly required to perform individual jobs. They have contributed importantly to the gains in efficiency made steadily since the new plant was occupied. As an indication of what this means, Mr. Gale states that output has increased fivefold during the past three years while manpower has grown but three times. When these facts were gathered during the final week in March, a new schedule calling for a 16 percent rise in daily Servi-Cycle production was being put in operation and plans were underway for a similar increment within a few months. It was not believed that the shop force would have to be increased by more than a few men to accomplish these objectives.

Simplex formerly maintained assembly plants in San Francisco, Calif., and Baltimore, Md., and shipped parts to them from New Orleans. Both of these auxiliaries have been discontinued recently on the theory that any saving in transportation costs effected by assembling some of the units in the general regions where they are to be sold will be more than offset by the efficiency with which the main factory now operates.

The current price of the Servi-Cycle represents a reduction from prewar figures and reflects economies in manufacturing costs resulting from the steps that have been mentioned. "We are striving to find ways to reduce our selling price further," says Mr. Treen, who is sole owner of the Simplex Manufacturing Corporation. "I believe that America became great largely because its manufacturers have had the ingenuity and industry to make better products all the while and continually lower prices. I think that we should continue along those lines."

CRATING

Even packing has been speeded up by using a small pneumatic impact wrench to run down nuts on bolts that secure the powercycle to the crate bottom at three points. Following bolting, the sides and top of the wire-bound wooden box are put in position and fastened. The front wheel is detached and placed alongside the machine to cut down the height of the shipping container.

Applying Cement Mortar as Dense as Granite

APPLICATION VIEWS

In the upper picture, showing stucco being applied to a cinder-block wall, the tank at the left contains water under air pressure. The cone-shaped hopper holds a sand-cement mix which is ejected from the nozzle by compressed air in combination with water. In the other view, the weather-eroded surface of a concrete grain elevator is being repaired by the Bondact process.

THE application of fresh cement mortar to masonry sometimes presents a problem because it is difficult to insure a firm bond between the old surface and the new. When placed upon a dry face it may shrink in curing and pull away. Therefore it is often necessary to drive spikes, rods, or the like to serve as anchors for the fresh mortar. The use of these devices is obviated, it is claimed, by a method of application with equipment manufactured by The Consolidated Sales Company under the trade name of Bondact.

By the process, a mixture of dry sand and cement is put in a hopper connected by a flexible hose to a hand-held spray gun. Compressed air entering the gun from a side port creates a vacuum that siphons the mix from the hopper and, in combination with a jet of water admitted through another port, forcibly ejects the mortar from the nozzle. The water is atomized by the air and hydrates the cement before application of the mix.

At the beginning of the operations the equipment virtually sandblasts the surface to be covered or repaired because the mortar strikes with such an impact that most of the grains of sand rebound, leaving behind their cement coating, which penetrates cracks and pores. When a film of neat cement approximately 1/64 inch thick has been deposited, the sand becomes embedded and only about 25 percent of it continues to rebound. This layer serves as a bond between the old and the new materials, which may be built up to any desired thickness.

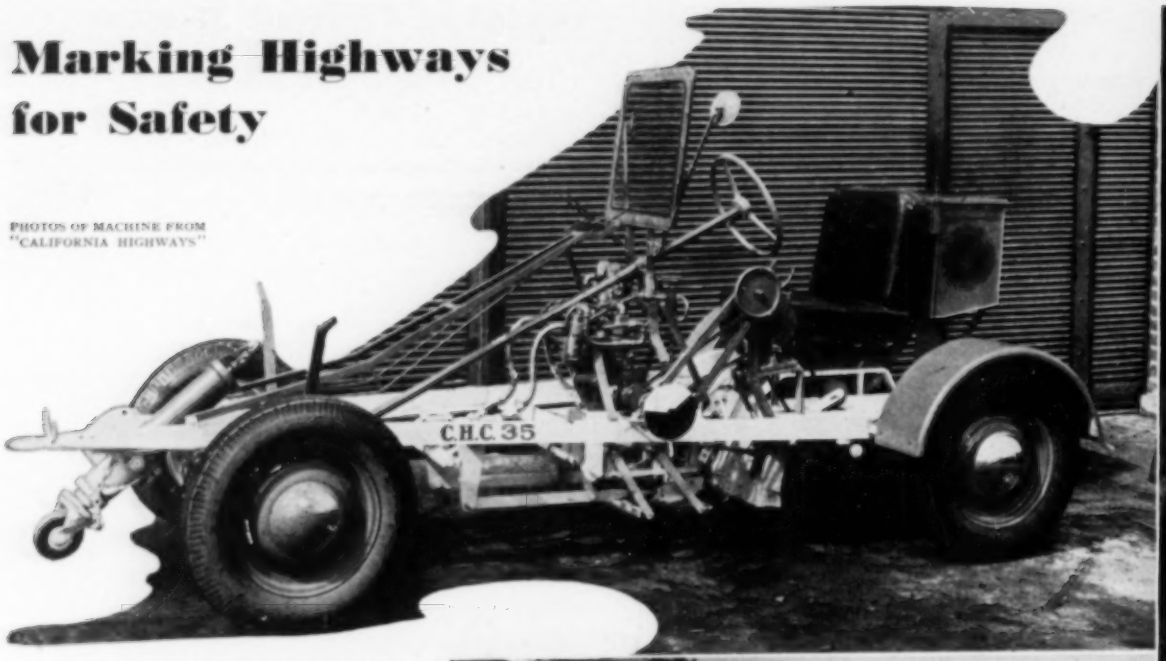
A compressor of 105-cfm. capacity is required to operate the Bondact gun. Best results are obtained by maintaining a pressure of 80-90 psi. at the gun and by wetting down the surface to be covered. Where the pressure of the water available is too low for satisfactory work, a special tank is used and compressed air is taken from the regular source of supply to force the water out through a hose connection to the gun. The mix is composed of one bag of cement and 4 cubic feet of sand, a quantity sufficient to apply a coat ⅛ inch thick on 135 square feet of surface or 1 inch thick on 30 square feet. It is claimed that two men working under normal conditions can apply twelve such batches with one gun in an 8-hour day. Deposited ¼ inch thick, this would mean 1100 square feet of surface covered.

The sand must be clean, sharp, and dry. It may be of the kind used for sandblasting, or of a size that passes through a screen of ⅛-inch mesh. Because some of the sand does not adhere, the resultant coating has an average cement-to-sand ratio of one to three. About 3 gallons of water is added per sack of cement, enough for hydrating and setting but not to lubricate the mortar so as to cause it to flow. As a result, the deposited material is dense and compact and will undergo only negligible shrinkage in drying. Its weight averages 172 pounds per cubic foot, which is approximately the same as that of granite. It is claimed that the compressive strength of concrete placed by the Bondact process is more than three times that of the best vibrated concrete.

The process has many applications. It is suitable in the construction field for waterproofing masonry walls; lining water reservoirs; joining or repairing sewer and water mains of tile or concrete; coating brick, concrete, tile, stucco, and other structures; and for repairing bridge piers and abutments. Industrial plants can use it for patching heavy-duty floors and loading docks worn by trucking, etc., relining chemical tanks, and for lining furnaces. Railroads can do all sorts of repair and maintenance jobs with the equipment, and highway departments should find it helpful in patching paving, in keeping sidewalks and curbing in repair, and in coating metal and masonry surfaces.

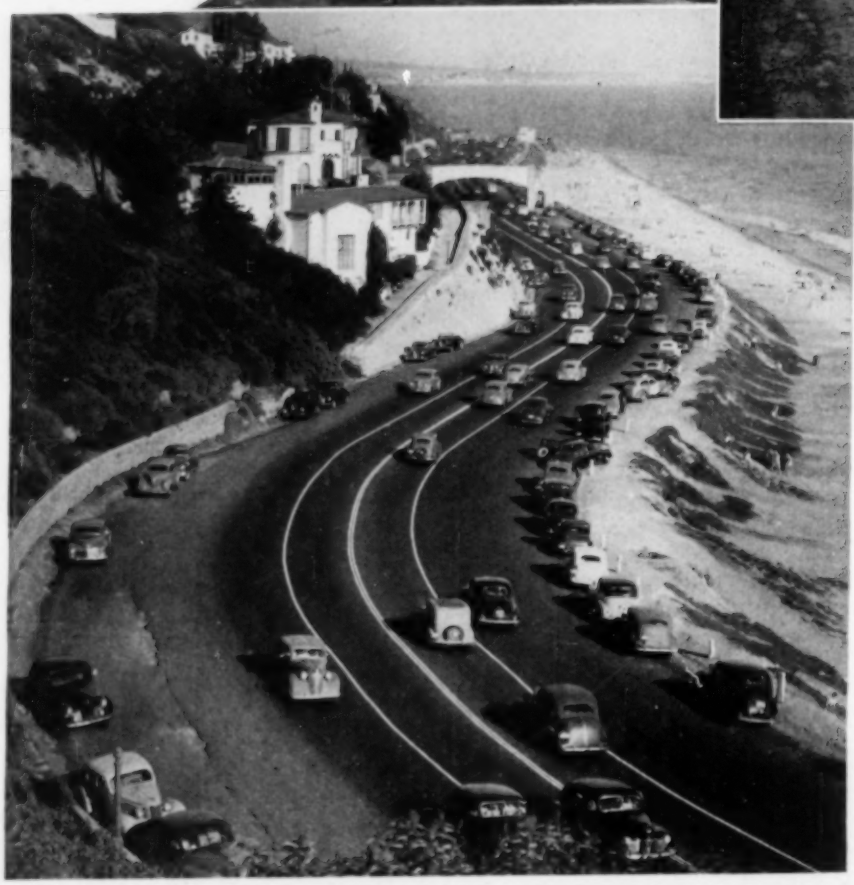
Marking Highways for Safety

PHOTOS OF MACHINE FROM "CALIFORNIA HIGHWAYS"



LATEST CALIFORNIA TRAFFIC STRIPER

All mechanical parts are exposed for easy adjustment, cleaning, or removal. When in service, the marking machine is pushed by a truck. For moving it between jobs, its front end is jacked up by means of the air cylinder shown between the wheels, and the assembly is then attached to the rear of the truck.



ADEQUATE marking of pavement surfaces has long been recognized as one of the best means of controlling highway traffic for safety. All motorists are familiar with the painted lines. They know that they are placed there to safeguard them but they don't always heed them. Despite the infractions of careless drivers, however, there is no doubt that markings prevent accidents and that the safety record, bad as it is, would be infinitely worse without them. In fact, President Truman's Highway Safety Conference last year urged the states to concentrate on the improvement of the highway center stripe in a major effort to reduce the ghastly toll of head-on collisions and side-swiping accidents.

Through standards defined by the Joint Committee on Uniform Traffic Control Devices, the states generally adhere to the same pattern of markings—stripes 4 inches wide. Their placing is the job of the state-highway departments, and they have devoted much research to the problem of finding out how to do it in the best possible way. Their studies have involved testing and selecting marking materials for satisfactory and enduring service and devising efficient equipment for applying them.

In the search for suitable materials, they have had the coöperation of paint manufacturers, and, in addition, some states have established their own laboratories and developed their own formulas. Lacquer is preferred because it best meets the requirements for a material that will dry quickly, adhere well to concrete and various bituminous roadways without serious discoloration, and effectively resist the wear of heavy traffic. During and following the war, the best quality lacquer was unobtainable. The prewar material often lasted eighteen months or longer, whereas the wartime product frequently had to be replaced five times during a like period. In recent months, the quality has become better, but it is still below standard.

With regard to striping equipment, commercial manufacturers have been hampered in their attempts to meet the demand because of the numerous changes in stripe design. Consequently, many states have planned machines that will serve their particular needs. There has been a free interchange of ideas, with the result that improvements made in

EWING GALLOWAY PHOTOS

PAINTED TRAFFIC COPS

Stripes on highway surfaces regiment the incessant motor parade that has come to be a prominent part of the American scene. They are invaluable safety aids for night drivers, and are especially welcome in fog or rain. The view at the left was taken just north of Santa Monica, Calif., and depicts a prewar Sunday motor cavalcade on U. S. Highway 101. Broken lines, instead of solid ones, were adopted as a wartime conservation measure to divide the lanes on either side of the roadway and are now fairly standard in all states. Double, white center markings are well-nigh universal. The other picture shows short, dashed stripes on a highway approach to Bear Mountain Bridge in New York.

one section of the country have been adopted elsewhere if they could be used to advantage.

Because of favorable climatic conditions that have given rise to heavily congested automobile traffic in California, the accident-prevention problem in that state is more serious than it is in the country generally. Multilane highways are common in its urban districts, and adequate marking is essential to safety. It is only natural, then, that California has been a leader in the development of striping apparatus. The task has been and is the twofold one of providing machinery that will not only mark the surfaces well but also do the work at a speed that will permit covering extensive highway systems without the use of so much equipment and manpower as to make for inordinately high costs. The state's latest striping machine was designed last year. It is the joint effort of numerous individuals in the Division of Highways of the Department of Public Works and reflects the cumulative experience gained with previous models. After one of the new units had been built and tested, the construction of eleven more was begun.

The first marking equipment used in California was pushed by the operator, who walked behind it. Towing by a truck was next tried, and was continued until it was found that better results could be obtained by putting the truck behind the machine. The first push-type unit was constructed in 1935 and was followed by eleven others. Each new model incorporated changes called for by modifications in striping design, and refinements and improvements were added from time to time. Most of the latter were based on suggestions made by the operators.

Well-nigh from the beginning the paint has been applied by means of pneumatic spray guns, and until recent years the markings consisted solely of solid stripes that could be placed with comparatively simple equipment. All that was required was a frame on wheels, with a seat for the operator and supports for the spray guns and hose lines through which paint and compressed air are delivered. The tanks containing the marking material and the compressor that furnished the air were mounted on the pusher truck. Later on, a mechanism was incorporated for dropping glass reflector beads on the freshly painted stripes to make them visible at night.

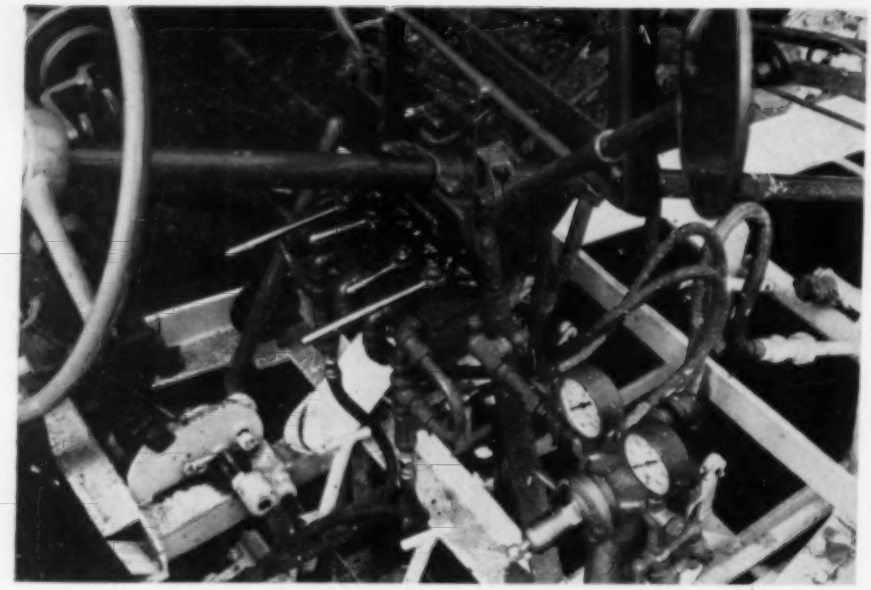
During the war it became the practice to use broken stripes for certain purposes as a conservation measure, and this made it necessary to devise some means of starting and stopping the guns at definite intervals. Operation of the bead dispenser and the paint sprays also had to be synchronized. The development of satisfactory apparatus was complicated by the fact that when old markings were renewed the superimposed stripe had to be aligned precisely with the previous one.

In the wartime machine, the painting cycle and, hence, the length of the stripe were controlled by a disk valve actuated by a bicycle wheel in contact with a drum on the rear axle of the unit. The same mechanism operated the bead dispenser. It was found that the length of the stripe was affected by any change in the driving wheel's radius, which differed with the temperature, the weight of the operator, and with fluctuations in tire air pressure. It was therefore necessary to make frequent adjustments—to speed up or retard the operation of the spray guns and bead dispenser—so as to compensate for these variables.

It was evident that more positive control was needed if the previously laid stripes were to be properly retraced; and as field experience had suggested other improvements, it was decided to redesign the apparatus. In doing this, the principal aim was simplicity of operation. With the present-day pattern of markings, the operator must be able without stopping his machine to shift from any one to any other of the following types of striping: A single white broken line; double solid white lines; double white lines consisting of a solid one on the right and a broken one on the left; double white lines with the solid one on the left and the broken one on the right; and a solid black stripe between double white lines. The second requirement was uniform application of beads synchronous with striping at a steady, desirable rate.

In addition to all these things, the designers sought to provide means for painting an offset stripe adjacent to a traffic barrier or other place where the machine could not be run directly over a line. Another objective was a unit built so that roughness of the pavement would not seriously affect the alignment of the stripes. Final considerations were: comfort and convenience of the operator, and arrangement of the hose lines and spray guns so that they might be cleaned as quickly as possible at the end of each working period.

As developed, the new machine looks much like the preceding model. It has a higher, more comfortable seat and is provided with foot rests. A windshield and rear-view mirror have been added. The spraying equipment is directly in front of the operator in plain view and with all controls within convenient reach.



SPRAY-GUN CONTROLS

The four levers underneath the base of the steering-wheel post are within convenient reach of the operator. The two longer ones control the flow of lacquer to the spray guns under the chassis and also the dropping of reflector beads with which white stripes are coated for night visibility. As pictured, the levers are in the "off" position. They can be set for the continuous painting of solid lines or for intermittent operation to produce dashed lines. The shorter central levers control compressed air admitted to the guns for atomizing the lacquer. Air-pressure gauges are shown at the lower right.

There are three paint nozzles, two for white lacquer and one for placing the black stripe that is sometimes inserted between double white ones. The entire assembly may be readily removed for cleaning.

The controls—four small levers, two short ones and two longer ones—are different and simpler than those previously used. Through the medium of 3-way valves, the two longer ones control the painting of white lines and the deposition of beads on them. With the lever set in one position, a continuous stripe is painted; in another the line is broken at regular intervals, the standard dashed marking consisting of 9-foot-long stripes spaced 15 feet apart. Of incidental interest is the fact that such a line requires only 40 percent as much lacquer as a solid one.

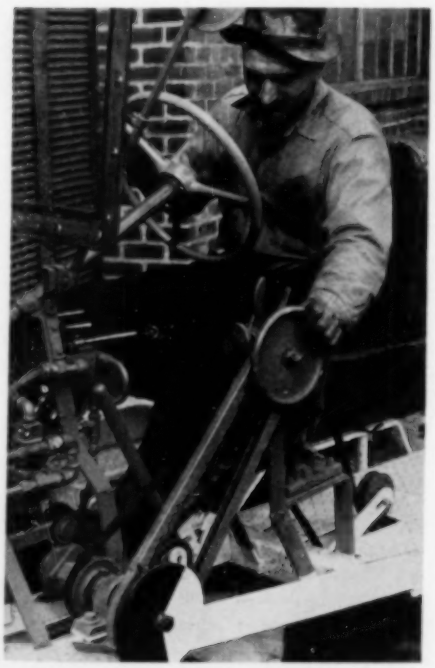
Two poppet valves turn the spray guns on and off automatically at the proper intervals when broken lines are being laid. These valves are operated from an adjustable cam which, in turn, is driven by one of the rear wheels. A revolving disk (see accompanying picture), with black and white segments in proportion to the nonpainting and painting periods of a cycle, serves the operator as an indicator. By means of a hand wheel he may make any adjustment necessary to insure that the ends of the new and old stripes will coincide. Further, provision is made for changing the length of the dashes and the distance between them, if that should be desired.

Operation of the spray-gun control levers also starts the application of beads which are stored in two compartments, one behind each white-paint spray gun. A cone with fins extends into the bottom of each compartment. By slightly lowering the cone, the beads flow down over it, the fins distributing them evenly on the line. The cone is welded to a shaft connected to a pneumatic cylinder. When compressed air is turned on, the piston lowers the cone; when the air is shut off, a spring raises the cone and stops the flow of beads. The dispensers are connected by flexible metal hoses to a box in which the beads are stored. This chamber is directly behind the operator's seat and has a window in the back which enables the driver of the pusher truck to observe when the supply of pellets is getting low and needs replenishing. The two shorter levers control the spray-gun atomizers and are turned off only when the apparatus is not functioning.

When a striping machine is being pushed from one working place to another, its front end is raised and attached to the rear of the truck. As that part of the apparatus weighs 650 pounds, an air cylinder is built on to it to do the lifting. The piston brings pressure to bear against the pavement, while a rubber-tired caster at its lower end permits shifting the front end of the machine sidewise after it has been elevated to make the hook connection. By this arrangement it can be raised 36 inches from the ground.

As the improved striping units are put in service, most of the pusher trucks also are replaced. Each new truck has its cab over the engine and directly behind the marking machine, giving the driver the best possible visibility of the road when the assembly is moving. Because speedometers are not accurate at the low speeds at which striping is done, the trucks are provided with engine tachometers so that they can be operated at a uniform rate conducive to the best performance of the spray equipment. Mechanically driven agitators are installed in the lacquer tanks, and the trucks carry special apparatus for cleaning tanks, piping, and hose lines.

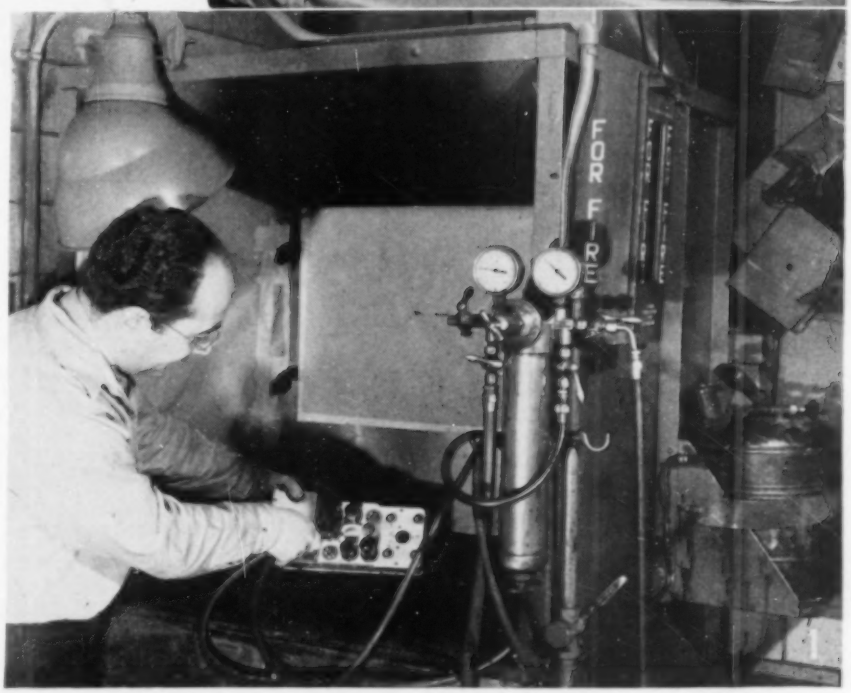
The new marking machines were built in the shops of the Division of Highways under the supervision of Frank E. Burnside, shop superintendent, and R. H. Stalnaker, equipment engineer. The cone-type bead dispenser was originated and developed by James J. Keleher, assistant mechanical foreman.



SPRAY-CYCLE CONTROL

When broken or dashed lines are being repainted, it is important that the new markings coincide closely with the old ones. This calls for careful steering to keep on the line and for turning the spray gun on and off with split-second accuracy. Intermittent spraying is controlled automatically by poppet valves operated by a cam which, in turn, is driven by a rear wheel. The black-and-white disk at the bottom of the picture is on the same shaft with the cam and indicates to the operator whether or not lacquer is being applied. It represents one cycle; that is, a line (white area) and a space (black area). The operator's left hand is on a wheel that enables him to make the necessary adjustment when the timing of the cycle is incorrect. Provision is made for changing the length of the dashes and the distance between them.

Intricate Equipment Parts Go to Dry Cleaner



HEAVY accumulations of dirt and grime on motors and control equipment can be readily slushed away by a method that has a novel aspect—it makes use of an ordinary dry-cleaning fluid mixed with compressed air. The solvent, which is converted into a high-velocity spray by means of a nozzle, dissolves or loosens the deposit, while the air stream blows the detached matter away. American Airlines has adopted this method at its LaGuardia Field overhaul base for motor parts, radio equipment, and aircraft instruments.

Some of the work is done in conventional spray-painting booths and with conventional equipment, while other cleaning jobs are performed with improvised facilities. The solvent may be drawn from a container fastened to the side of a booth (1), or it may be taken directly from the can in which it is supplied, the dirty fluid draining into a bucket, as shown in No. 2. The type of nozzle used depends upon the work and may be a standard air gun or one into which a tube is inserted. Attached to it at an angle is another shorter tube which serves as a connection for a length of hose leading to the solvent container (3). The latter may be held by the operator or set anywhere on the worktable, as may be most convenient. In its passage through the elongated nozzle, the air sucks the fluid out of the can and atomizes it at the same time. After cleaning, the parts are dried by a blast of compressed air.

The solvent used by American Airlines is of comparatively low flammability and nonexplosive, following, generally, the specifications of Stoddard solvent, a standard fraction of petroleum characterized by a flashpoint of 100-105°F. Motor and engine parts are cleaned with a fluid having a slightly higher flashpoint, while instruments get a bath with highly refined naphtha. Air pressures vary, of course, with the work and its condition. In the case of engine parts, the solvent is applied at from 90 to 110 psi., while the maximum for radio equipment and delicate instruments is 30 pounds. The air is filtered to remove moisture, dust, and any scale that might be in the supply lines. Used solvent is recovered by American Airlines and is good for several applications provided it is not too heavily laden with oil. It is first allowed to settle in a tank provided with a valve to drain off water and sludge, and then goes to a special reclaiming unit.

The pictures show typical jobs and equipment. From top-left to bottom, workers are engaged in spraying cleaning solvent on an engine part, a radio transmitter, and a radio receiver to remove dirt and grime.

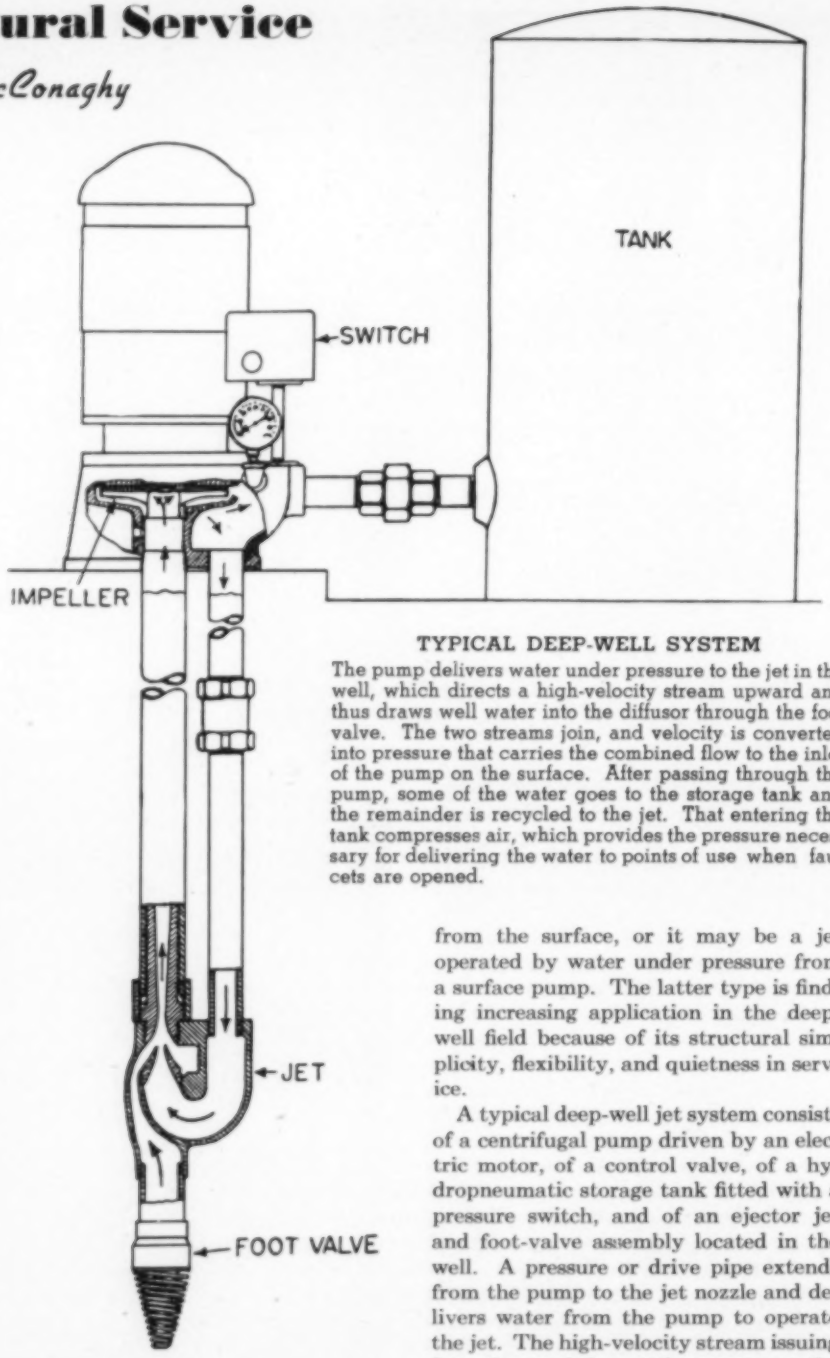
Jet Pumps for Rural Service

J. W. McConaghy

RURAL dwellers and suburbanites whose homes are beyond the reach of city water mains often experience difficulty in securing an adequate supply of running water. Surface water from springs, lakes, ponds, or streams is seldom suitable for human consumption. Because it is rarely free from contamination, if not lacking in quantity, most rural inhabitants obtain their supply from wells whose depths vary in accordance with the elevation of the water table below the earth's crust. The deeper that level, the greater the problem of lifting the water to the surface. One way in which this may be accomplished is by the use of a jet pump, a type that is becoming increasingly popular.

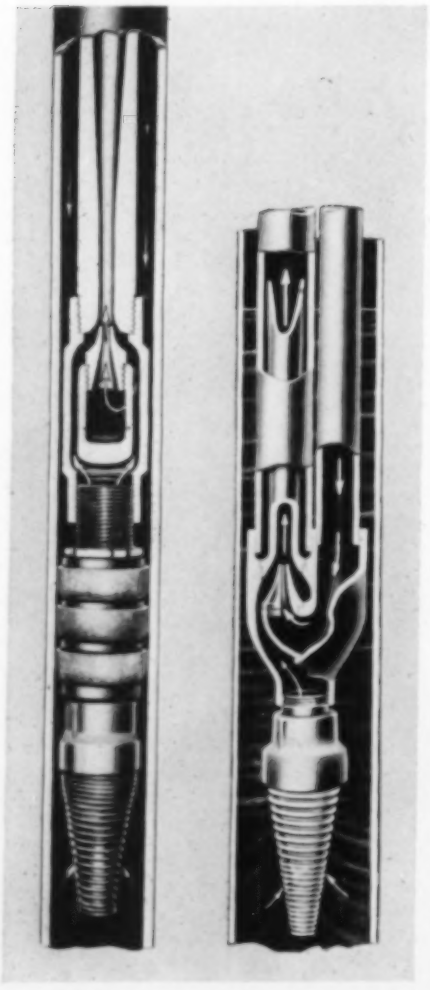
Pumping systems are generally classified as follows: shallow-well if the distance from the pump to the water level is less than 20 feet; deep-well if the footage is greater. Units for shallow-well duty are designed to use atmospheric pressure to raise the water. Such pumps create a partial vacuum at the inlet, causing atmospheric pressure to force the water up a suction pipe. Theoretically, at sea level, water could be lifted 34 feet, but the mechanical limitations of the pumps reduce this to a maximum of 25 feet.

When the water table is more than 25 feet below the pump, it is necessary to submerge the pumping element in the water. The type used in this case may be a plunger pump actuated by a rod from the surface, or it may be a jet operated by water under pressure from a surface pump. The latter type is finding increasing application in the deep-well field because of its structural simplicity, flexibility, and quietness in service.



TYPICAL DEEP-WELL SYSTEM

The pump delivers water under pressure to the jet in the well, which directs a high-velocity stream upward and thus draws well water into the diffusor through the foot valve. The two streams join, and velocity is converted into pressure that carries the combined flow to the inlet of the pump on the surface. After passing through the pump, some of the water goes to the storage tank and the remainder is recycled to the jet. That entering the tank compresses air, which provides the pressure necessary for delivering the water to points of use when faucets are opened.



WELLS OF TWO TYPES

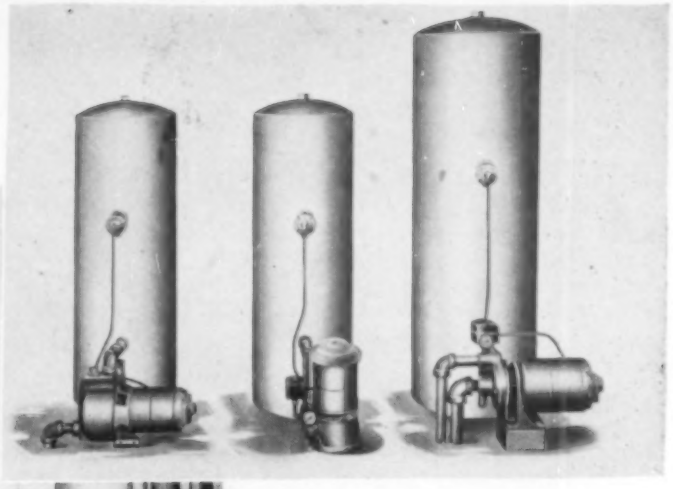
A dual pipe system (right) may be used within the casing where the well diameter permits. In smaller wells, the casing itself serves as the pressure pipe to the jet, and the upward flow is carried by an inner central pipe, as seen at the left.

A typical deep-well jet system consists of a centrifugal pump driven by an electric motor, of a control valve, of a hydropneumatic storage tank fitted with a pressure switch, and of an ejector jet and foot-valve assembly located in the well. A pressure or drive pipe extends from the pump to the jet nozzle and delivers water from the pump to operate the jet. The high-velocity stream issuing from the nozzle lowers the pressure at the entrance to the jet diffusor, causing well water to enter through the foot valve. The two streams mix in the diffusor, where velocity is converted into pressure.

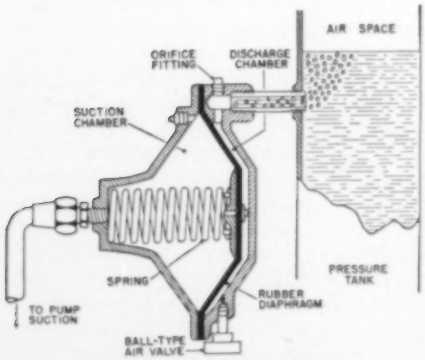
Under the influence of this pressure, the combined flow rises in the suction pipe to the inlet of the centrifugal pump at the surface. After passing through the pump and increasing in pressure, the stream divides, some of the water entering the storage tank and the remainder going to the jet for its continued operation. Separation is effected by a control valve interposed between the pump and the tank and designed so that it will maintain sufficient pressure on the jet nozzle to force the well water up to a point where the pump can pick it up.

VARIOUS PUMP ARRANGEMENTS

The view below shows a ½-hp. Ingersoll-Rand Superjet pump that supplies a country club with water. Units of this type for pumping from maximum depths of 120 feet are available in five sizes ranging from ¼ to 1 hp. Typical set-ups are at the right. Units of more than 1 hp. are built for deeper wells and greater pumping capacities.



Use of a conventional hydropneumatic storage tank with the jet pump permits making the system entirely automatic. As the water in the tank rises, it compresses the entrapped air, and when a predetermined pressure is reached, the pressure switch shuts off the pump. Water is then delivered from the tank to the point of consumption until the pressure drops to the lower limit of its working range, when the switch again turns on the pump. During the time the latter is not operating, the foot valve remains closed. This keeps the entire system under storage-tank pressure and full of water so that no priming is necessary when the unit resumes pumping.



BRADY AIR-VOLUME CONTROL

This device functions to maintain air in the storage tank under the desired pressure. Its operation is explained in the article.

Because well water is not always saturated with air, it is often found that the air cushion in the storage tank is partially absorbed by the water and must be replenished. A simple control device by which the proper pressure can be maintained in the tank is a spring-loaded diaphragm. One side of it is connected to the suction of the pump, the other to the storage tank through the medium of a small orifice and to the atmosphere by a spring-loaded check valve.

When pumping starts, the suction side of the diaphragm is under reduced pressure and is forced in that direction by the spring. If the water level in the tank is above the orifice when this action takes place, atmospheric air can enter through the check valve at a faster rate than water can flow through the orifice. A small amount of air is thus drawn into the device and remains there until the pump ceases to operate and the spring returns the diaphragm to its former position. This causes the air on the inner side of the control to pass through the orifice and to enter the tank. The device will take in no air from the atmosphere when the water level is below the check valve, for the air from the tank will pass through the orifice at a faster rate than atmospheric air can be drawn in through the valve.

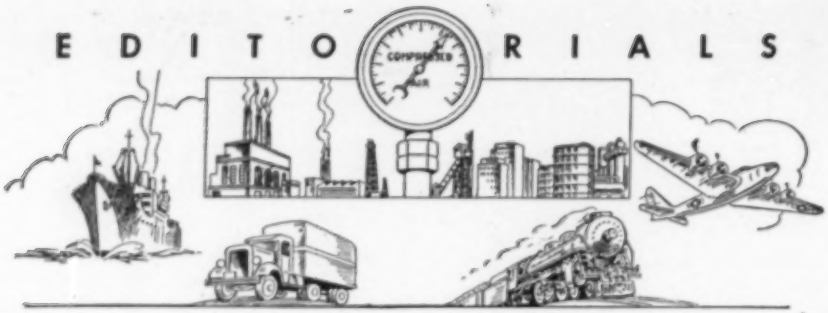
Jet pumps possess several advantages over those of the plunger type. The latter often makes considerable noise when in operation because of the reciprocating action of the plunger rod and the pulsating nature of the flow of water. Furthermore, replacement of worn moving parts often necessitates the removal of the entire rod from a well. The most important feature of the jet pump is that it has no moving parts in the well proper. In consequence, it not only runs noiselessly but its submerged section normally does not require repairs.

Another advantage of the jet pump is that its surface components need not be located directly over the well but can be offset where installation problems demand such a procedure. This permits placing them in a building some distance away from a well. Jet pumps can be manufactured in well-nigh any size and capacity, and for any depth of well. That they are being used in increasing numbers is indicated by U. S. Department of Commerce statistics which show that more than 350,000 such units were produced in 1947.

Some idea of the value of an automatic pump on a farm can be gathered from the following data. While the total consumption varies, of course, with the size of the household and the number of animals to be tended, we are told that the daily requirement for each member of a family is 25 gallons; for laundry and dish washing, 200 gallons; for a horse, 10 gallons; a cow, 15; a hog, 3; for 100 chickens, 4, and so on.

Anyone who has had the chore of bringing water up from the ground by means of a hand pump, or who has had to tinker with a gasoline engine-driven unit on a cold winter's morning, will tell you that it takes a lot of water to supply the multiple needs. To him the modern electric pump such as the jet system is both a necessity and a luxury and saves him precious minutes, aside from labor, that he can devote to one or other of the many tasks that always remain to be done on a farm.

EDITORIALS



MODERN HIGHWAY BUILDING

CONSIDERING the current extent of our intermeshed ribbons of concrete and "blacktop," it is difficult to comprehend that the American program of roadbuilding did not begin until 1890. Yet that is true, as was pointed out in a recent address before the Michigan Highway Conference by Charles M. Upham, engineer-director of the American Road Builders Association. Visitors from abroad in the latter part of the nineteenth century classified our roads as the worst of any civilized nation.

Beginning in 1792, we constructed a considerable mileage of turnpikes with private capital. They were surfaced with pounded stone and cost about $7000 a mile. The period between 1810 and 1830 was the canal era, and it was followed by a railroad boom. People said there would never be a need for many highways. But the advent of the bicycle gave an impetus to roadbuilding, and when the automobile came along, modern highway construction had its real inception. In 1891, New Jersey enacted the first law providing state aid for roadbuilding up to one-third the cost. Financial aid is now given by the Federal Government, and 614,000 miles of highways are eligible to receive it.

During the comparatively brief span of modern road construction there has been a revolution in contractors' equipment. About the only machinery available in 1890 was the rock crusher, invented in the United States in 1858, and the steam roller, originated in France in the following year. The ideal highway of that day was water-bound macadam. In this country, contractors considered steam rollers too expensive and used horse-drawn rollers for many years. Other equipment consisted mainly of picks, shovels, wheelbarrows, carts, horse-drawn scrapers, and black powder. A complete contractor's outfit could be bought for around $2500. Modern roadbuilding machinery was born in the 1920's with the adoption of the gasoline engine for various types of machinery. Although the mechanical rock drill had been available long before that time, its application was then multiplied by the appearance of the portable air compressor.

Power-driven highway equipment has now attained such importance that Mr. Upham estimates $650,000,000 of it will be bought in 1948. This is a huge sum, but experience has shown that each advance in mechanization has decreased construction and maintenance costs. It would be an almost impossible and never-ending task to build a modern highway with deep cuts and heavy fill with 1890 machinery.

We now have around 37 million power-driven vehicles on the roads. We spend about eighteen billion dollars annually for transporting goods by highway and fifteen billion for operating pleasure and business cars. To extend our road network and to keep existing highways in repair requires expenditures of approximately 2.5 billion dollars annually.

Since unit costs go down as mechanized equipment improves, the development of better machinery saves the taxpayers dollars and is of great public interest. In July, hundreds of manufacturers will show their latest creations at the 1948 Road Show in Chicago. Thirty acres will be given over to the displays, and every contractor of importance in the nation will be there.

OUR FUTURE IRON

IN TWO more years the Lake Superior iron ranges will have been producing an even hundred years. During that period the region has accounted for around 85 percent of the domestic iron-ore output. In 1947 it yielded 82 percent of the 93,248,000 tons of ore mined within our borders. The exhaustion of the high-grade ores in this great reservoir has been foreseen for many years. The latest estimates are that it still contains about 20 years' supply at the current rate of extraction. Once this reserve is depleted we will, perforce, have to rely upon the lower-grade taconite ores of the same area, supplemented by such quantities of high-grade ores as can be developed from our other producing sections and as can be imported.

In 1947 we imported approximately 5 percent of the ores we consumed. These came principally from Chile, Canada, and Sweden. On the other hand, we exported a record amount of ore, mainly to Canada. This seeming paradox is accounted for by the fact that Canadian production, although small in comparison with ours, is exceptionally high in iron content. Consequently, our northern neighbor used Lake Superior ore to dilute its rich ores and sent us some of the latter for enriching our own output.

Since mining of the Lake Superior deposits began, they have given us approximately 2300 million tons of ore containing around 51 percent of iron. According to figures cited a year ago by C. M. White, president of Republic Steel Corporation, the lower-grade taconite reserves in the same area aggregate 67,000 million tons of ore averaging 35 percent in iron content and containing more than 23,000 million tons of actual metal. However, a complete new technology of beneficiation must be developed to bring the iron content of this ore up to the range that is now commonly fed to our blast furnaces. Either that must be done or more blast furnaces must be erected to bring the yield of metallic iron to the current level when charging the lower-grade ores. Either course will be expensive. However, the steel industry has had the problem under investigation for years and is pursuing an intensive program of research aimed at giving its plants a continuing supply of raw material.

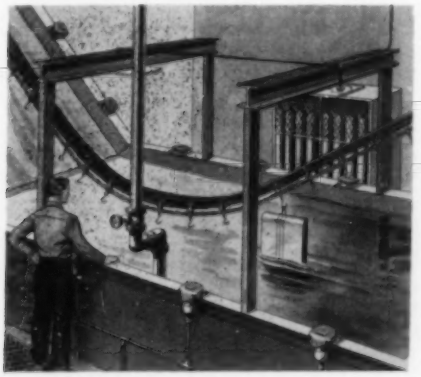
Aside from the Lake Superior region, our greatest reserves of actual and potential ore are the magnetite deposits of New York, New Jersey, and Pennsylvania. These supplies could be augmented by imported ores. However, it is not desirable under our present distribution of steel-making facilities to obtain the bulk of our ore from these sources. Transportation costs from the eastern seaboard to existing mills in the Pittsburgh and Chicago areas would add appreciably to the selling price of steel products. The alternative would be to move an appreciable number of the plants eastward, and the cost of this would be monumental. The desirable course, it seems, is to find ways and means of utilizing the low-grade ores of the Lake Superior district.

From an international viewpoint, our iron-ore position is not encouraging. Of the estimated 16.2 billion tons of iron metal in the world ore reserves and available for use under existing steel-making practices, the United States possesses only 10.5 percent. However, we have been producing 40 percent of the world's steel. Obviously, if this course is continued, our supplies will be exhausted long before those of some other nations. Nevertheless, much of the universe is looking to us for steel, and it is imperative in the interest of world peace that we keep making it at the current rate, or even at a higher one. This is also vital to the prosperity of our own country. With a huge national debt, our industrial output must be maintained at a high level if we are to escape a major readjustment; and this, in turn, calls for a large and sustained output of iron and steel.

Industrial Notes

After a long period of testing and research application, the Hagan Corporation has put in production a device by which physical motion can be recorded through the medium of air pressure. Described as a new development in the field of instrumentation, the Microtrans, as it is designated, translates physical movement of 0 to 0.25 inch into pneumatic pressure ranging from 5 to 30 psi. According to the company, it is being used effectively in determining the expansion of turbine rotors in relation to turbine casings.

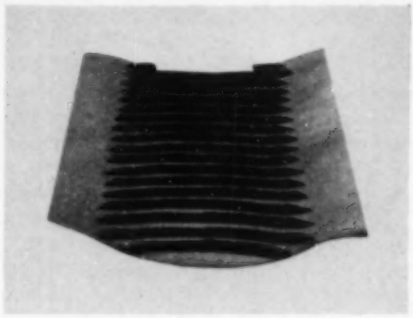
For smothering dip-tank and drainboard fires with carbon-dioxide gas, engineers of Walter Kidde & Company have developed an L-type Multijet Nozzle that overcomes the objections of earlier equipment of this kind with its complicated overhead piping and horn-



type nozzles that often interfered with the movements of conveyors and operators. The new design permits installation of inlet piping close to tank sides and has a flange to facilitate mounting on top of the reinforcing angle that is a feature of most tanks. It emits the gas in a fan-shaped blanket that hugs the liquid surface, a pattern that offers greater protection than did earlier systems with more nozzles and piping. Inspection, maintenance, and cleaning likewise are simplified.

Chevrolet has a new automobile accessory that literally "borrows from Peter to pay Paul." It's a length of hose with the ends equipped so that it can be connected to the air valves of two tires. If you have a leaky tire it may serve to inflate it sufficiently to permit you to get to a service station by tapping a little air from the spare and each of the three sound tires.

Engineers of the Goodyear Tire & Rubber Company have designed a conveyor belt especially for the delivery of soupy materials that have a tendency to backwash when carried up inclines on smooth-surface belts. To obviate



this and the resultant heavy wear and tear, the new conveyor is provided with closely spaced shevron-shaped ribs ¼ inch high. These trap the water and noticeably prevent concrete, wet sand, gold dredgings, etc., from slipping backward on gradients up to 20°. Because the curved ribs overlap one another, the return run over idlers is said to be smooth. The belt has a 5-ply rubberized-fabric body and a ¼-inch top cover in addition to the ribs. It is made in widths of 30 to 48 inches in specified lengths.

For the overhead distribution of steam, process liquids, oil, and viscous fluids that should be maintained at a specified temperature, Ric-wil Company is offering heavily insulated piping ready for installation. First covered with any specified insulation such as asbestos or cork, the surface is next machine coated with asphalt; tension wrapped with asphalt-saturated asbestos felt; again coated with asphalt; and given a final wrapping of aluminum or copper foil. In addition to this basic type, company makes sections consisting of a pipe supported within an insulated pipe. Either may serve as the conduit for a process liquid while the other carries a heating or a cooling medium. Called Ric-wil Foil-clad, both kinds are made in 21-foot lengths.

Animal, vegetable, or synthetic textile fibers can, it is claimed, be accurately measured and classified for fineness by the Micronaire, an instrument now being produced by The Sheffield Corporation. Compressed air is forced through a plug of fibers, and its resistance to the flow, an indication of its degree of fineness, is read from a

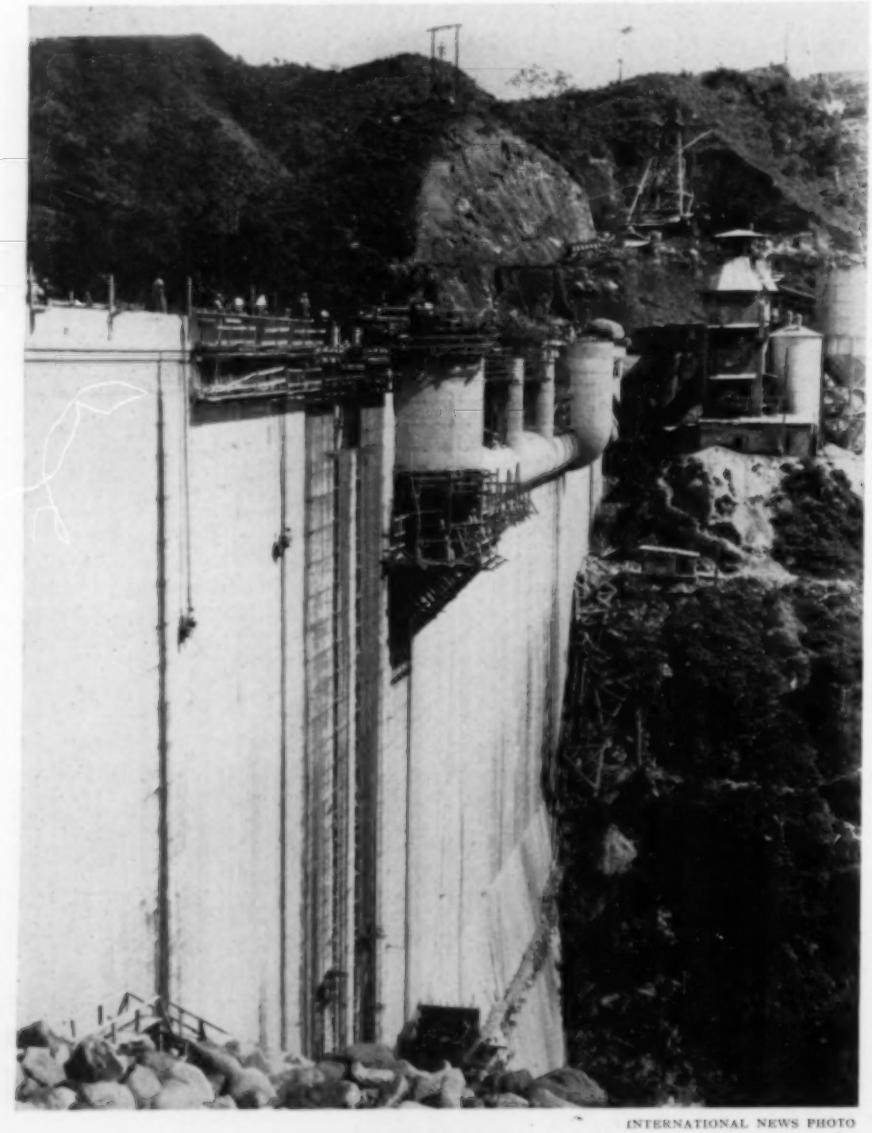
scale calibrated in units that are standard for the stock being checked. The company reports that a sample can be tested twice in two to three minutes, and that from 25 to 50 specimens can

PORTABLE DOCK FOR FLYING BOATS

The inflatable, rubberized-fabric dock with plywood decking shown here with a Mariner flying boat tied to it has been developed by the Navy Bureau of Aeronautics and the Goodyear Tire & Rubber Company to serve Navy seaplanes at advanced bases. It is made up of nine nylon-coated pontoons, each 25 feet long by 7 feet wide and containing four separate air chambers. They can be transported by plane and assembled in from four to six hours into a U-shaped structure 25 feet across and 103 feet long on the sides. It is large enough to accommodate one of the Navy's 72-ton Mars flying boats. Although intended primarily for mooring planes for loading and unloading, the new dock can be used for emergency plane repairs.

be measured in the same length of time that one is classified by conventional laboratory methods and equipment. Repetitive accuracy in the case of cotton, the textile fiber that varies most, is within 0.1 micrograms per inch.

A troughing idler of an adjustable type that is said to increase the life of conveyor belts has been announced by Koppers Company, Inc. With it, according to the manufacturer, it is virtually practicable to make the installation fit the belt and to provide a shallow or deep trough, as may be required. The outer inclined pulleys are adjustable from slightly above the horizontal to a maximum angle of 25°. All pulleys are located in the same vertical plane, and the outer ones are adjusted in a manner that maintains a constant gap between the ends of the horizontal and the inclined pulleys. This gap is kept down to a minimum to eliminate the possibility of belt damage through creasing or pinching. Idlers of the new design are said to be well suited for use at points where a conveyor changes from an inclined to a level path because they permit forming a vertical curve and depth of trough necessary to retain material without spillage and excessive belt stretch along the edges. At both feed and discharge ends, an adequate number allows a belt to flatten gradually, thus not only preventing abrupt distortion but also reducing strain on the belt as it enters or leaves the idlers.



INTERNATIONAL NEWS PHOTO

JUNIOR TVA

As the first step in Porto Rico's $100,000,000 industrial-development program, the Porto Rico Water Resources Authority has undertaken the Caonillas hydroelectric and irrigation project to be built at an estimated cost of $10,000,000. The dam, which is now nearing completion, is 220 feet high, 780 feet long, and will create a reservoir with a storage capacity of 39,000 acre-feet. A tunnel driven through rock and nearly 2 miles long will convey the water to the power plant, which will have an installed capacity of 24,000 hp. This will bring the island's total annual production to 400,000,000 kw-hrs., enough to satisfy current requirements. At present, much of its power is still generated by steam plants burning fuel oil, which has to be imported and is expensive. The chief engineer of the Water Resources Authority is Carl A. Bock who was previously associated with the Tennessee Valley Authority.

Two lines of fast-drying marking inks in a wide range of colors have been announced by Neehi Protective Coatings, Inc. They are intended primarily for color-code and specification marking by machine or by hand, stenciling, or spray gun. The inks, it is claimed, can be applied on any material, including asphalt and creosoted surfaces, are waterproof, and resistant to oils, acids, and alkalies. They can be thinned for use with a pen point.

Tarpaulins used during the erection of buildings in inclement seasons of the year have lately received a "new look." Bentek Corporation conceived the idea of fitting them with flexible-plastic windows to let in daylight. Several contractors in the New York area tried them this winter to complete housing projects and report that they expedite work because they dispel the gloom that has a depressing effect on men carrying on under cover of ordinary canvas enclosures and because they eliminate the use of shadow-casting electric lights that slow up operations.

Houghto-Solv is the trade name of a new fuel-oil additive that has been produced by E. F. Houghton & Company for the purpose of cleaning fuel-oil tanks and systems. The mixture is introduced into the storage tank in the ratio of one quart to 1000 gallons of oil and is said to remove all traces of sludge from tank to stack by making it a burnable part of the fuel. According to the manufacturer, the solution also stops formation of soot which insulates boiler surfaces and cuts down heat values, is noncorrosive and nontoxic, and meets all plant safety regulations.

Electronic vulcanization of rubber with which The B. F. Goodrich Company has been experimenting for several years has been adopted as standard practice by that concern for tubing, strip, thread, and other stock that can be run in a continuous line from an extruding machine. As explained by Goodrich engineers, electronic-energy waves, traveling at a maximum speed of 186,000 miles a second, agitate molecules in the rubber, causing internal friction that instantaneously generates a temperature of approximately 300°F. The process, it is claimed, considerably lessens materials handling during manufacture, improves the quality of the product, and in some cases has reduced the actual curing time from as much as 1½ hours to two minutes!

New Book on Pumps

A TECHNICAL book that covers a theoretical subject in an exhaustive manner yet presents the results in practical form is always welcome. In this class is a recent book on the theory, design, and application of centrifugal and axial flow pumps. The progress in this field has been so rapid that almost all limitations on pressure, capacity, temperature, nature of liquid, and speed of operation have disappeared. Few if any of the books available on this subject give an adequate account of this progress or deal with the problems arising from new practices and uses of these pumps. For this reason *Centrifugal and Axial Flow Pumps* by A. J. Stepanoff will be of considerable interest to those who work in this field.

Doctor Stepanoff, a development engineer for Ingersoll-Rand Company, is an authority on centrifugal pumps. He is a graduate of the University of California, having received his Ph. D. from that institution in 1930. During the intervening years he has been actively engaged in the design and development of centrifugal pumps, work that in 1932 earned for him the Melville Medal of the American Society of Mechanical Engineers. He is the author of many articles on various phases of centrifugal pumps, and his skill as a writer is attested to by three first prizes awarded to him in 1941, 1942, and 1943 for entries submitted to the Annual Engineering Essay Contest of the Hydraulic Institute.

Features of Doctor Stepanoff's book, which make it especially valuable to design and operating engineers, are theoretical and experimental studies of such subjects as cavitation, operation outside the normal head-capacity and speed ranges, axial and radial thrust, the effect of stuffing boxes on the critical speed of pump shafts, the control of head-capacity and brake-horsepower curves, and the pumping of viscous liquids. In addition, the theoretical treatment of impellers for centrifugal, mixed-flow, and axial-flow pumps has been reduced to a simple diagram that is applicable to all three types—serving, in a sense, as a "Mollier Diagram" for these pumps. Considerable space is devoted to special problems of pump design and application, and numerous examples of modern pump designs and installations are given. Altogether, the book is sufficiently technical for the most exacting of design engineers, yet may be read with profit by those concerned with the practical solution of pumping problems.

Centrifugal and Axial Flow Pumps is published by John Wiley & Sons, Inc., New York, N. Y., price $7.50. It can be obtained from our Book Department, and Doctor Stepanoff has agreed to autograph copies, if desired.

Dry Air

from the new filter with the longer-lasting cartridge

Air passing into MICRO-KLEAN FILTER first hits the baffle; any moisture not deflected, enters . . .

MICRO-KLEAN fibre cartridge where it must make hundreds of sharp turns through minute interstices, impinging on fibres.

Longer cartridge life is due to double dirt-collecting capacity and resinous impregnation which prevents wicking or channeling.

Moisture then drains from non-wicking fibres into extra-large collection chamber, equipped with petcock drain.

Standard Micro-Klean models handle volumes up to 80 cfm of free air and pressures up to 125 psi. They have been adopted as standard equipment on such widely divergent applications as pneumatic mine-equipment, powder dispensing devices, motor coach auxiliary air systems, spray painting systems, air instruments, etc. For more information, attach coupon to your letterhead.

CUNO

Fluid Conditioning

REMOVES MORE SIZES OF SOLIDS FROM MORE TYPES OF FLUIDS

Micronic · Disc-type · Wire-wound · Fabric Filters

Cuno Engineering Corporation
179 South Vine St., Meriden, Conn.

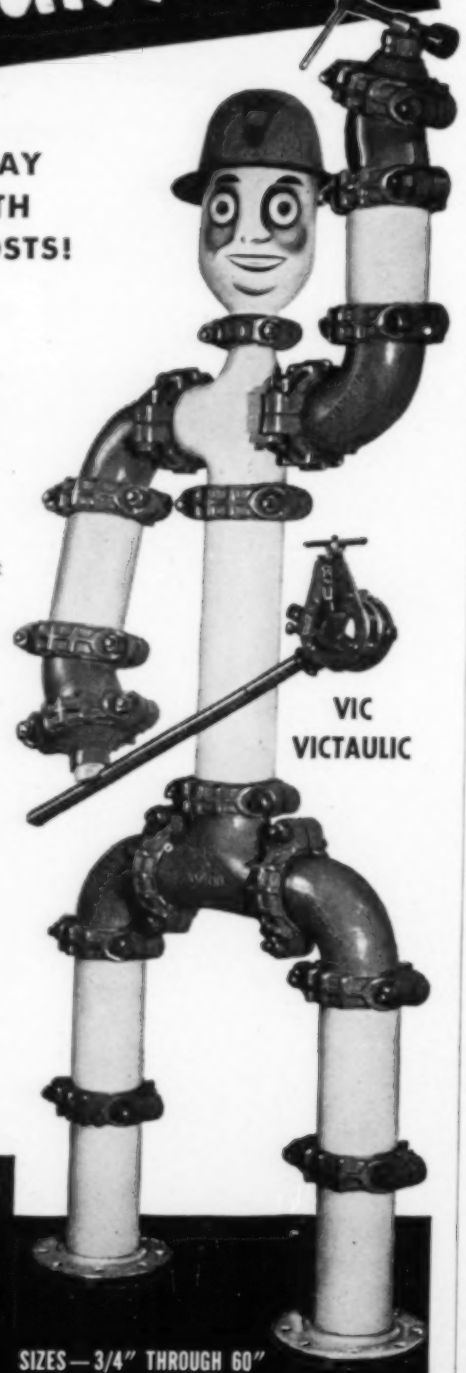
Please send bulletin on Cuno Air-Line Micro-Klean Filter:

Name.....

Company.....

Address.....

I'M YOUR MAN



FOR THE *FASTEST* WAY TO LAY PIPE... WITH *MINIMUM* LABOR COSTS!

ON "VIC VICTAULIC" at the right you can *see* the two-bolt simplicity of Victaulic Couplings that saves valuable man-hours and labor costs on installation of *any* piping system! Just a few turns of a standard T-wrench buttons up the two half-housings of Victaulic Couplings ...with no specially trained or skilled labor needed!

ALSO, THESE FEATURES are built into every Victaulic-coupled piping system: *flexibility* that automatically allows for contraction or expansion, lessens need for expensive bends and fittings...*a union at every joint* for easier, quicker repairs or salvage...*positive-locked* joints that can't pull out or blow off!

WHAT'S MORE, Full-Flow Victaulic Elbows, Tees and other FITTINGS increase pipe-line delivery *at lower pumping costs!*

REMEMBER, TOO—the new "Vic-Groover" grooves pipe ends with half the effort *and twice as fast* as ordinary pipe threaders!

WRITE TODAY for Victaulic Catalog and Engineering Manual No. 44...and for the new "Vic-Groover" Catalog No. VG-47.

SELF-ALIGNING PIPE COUPLINGS

VICTAULIC

EFFICIENT FULL-FLOW FITTINGS SIZES—3/4" THROUGH 60"

VICTAULIC COMPANY OF AMERICA

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Victaulic, Inc., 727 W. 7th St., Los Angeles 14, Calif.

Victaulic Company of Canada, Ltd., 200 Bay St., Toronto 1

For export outside U. S. and Canada: PIPECO Couplings and Fittings:

Pipe Couplings, Inc., 30 Rockefeller Plaza, New York 20, N. Y.

Copyright 1948, by Victaulic Co. of America

Industrial Literature

Norton Company, Worcester 6, Mass., has issued a folder describing its chemically balanced alloy of boron and iron for use in adding boron to steel and cast iron.

Typical applications of flexible couplings and recommended maintenance procedures are set forth in a 24-page booklet issued by the American Flexible Coupling Company, Erie, Pa. Book shows how misalignment between machines may be ignored if flexible couplings are used.

Baldwin Locomotive Works has issued a 12-page bulletin covering its line of bending rolls, flanging and crimping presses, and plate planers. The bulletin contains photographs and descriptions of the various types and may be obtained by writing to the company at Eddystone, Pa.

Pipe conveyors and accessories are described in a 40-page catalogue issued by Hapman Conveyors, Inc., 2405-12 West McNichols Road, Detroit 21, Mich. Engineering drawings of typical systems for the handling of flour, dust, coal, sand, lead, sludge, and other materials are included in the bulletin, copies of which will be sent on request.

Sarco Company, Inc., Empire State Building, New York 1, N. Y., will send upon request Catalogue No. 900 which describes the firm's new-model steam-and-water mixer. The device is of the injection type and is designed to provide hot water at locations remote from general hot-water systems or to act as a booster heater to provide higher-temperature water.

A bulletin describing nonrotating air motors is available from The Bellows Company, Akron, Ohio. This type of motor consists of a cylinder containing an air-operated piston that provides pulling, pushing, or lifting power. It is applicable to machine tools and to a variety of other industrial machinery.

Cerro de Pasco Copper Corporation, 40 Wall Street, New York 5, N. Y., has published the first of a series of data sheets containing information and illustrations on the applications and uses of their low-melting-point alloys. The sheets are in loose-leaf form and will be sent on request to interested persons.

Multicircuit unit substations are described in a 16-page bulletin recently issued by Allis-Chalmers Company. The bulletin gives details of construction of oil-filled, liquid-filled, and dry types of transformers, as well as of load-ratio equipment and metal-clad switchgear. Copies of Bulletin 11B6935 may be had from the company at Milwaukee 1, Wis.

Volume 4, Number 10 of the *Eutectic Welder* contains a condensation of a survey covering the weldability of several thousand commercial alloys. Different kinds of welds are given, together with the metals and alloys commonly used in making them and the heat range permissible. The layout is such that it can be hung up like a wall chart. Copies will be sent upon request to Eutectic Welding Alloys Corporation, 40 Worth Street, New York 13, N. Y.

Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., has issued a bulletin describing its line of high-pressure, multi-stage, centrifugal pumps. These are of the horizontal, single-suction, combination turbine and volute type, and may be used for boiler-feed service, for draining deep mine shafts, and for other purposes. They may be

driven by an electric motor, by a steam turbine, or by an internal-combustion engine. The bulletin may be obtained by requesting Form 7153 from the company.

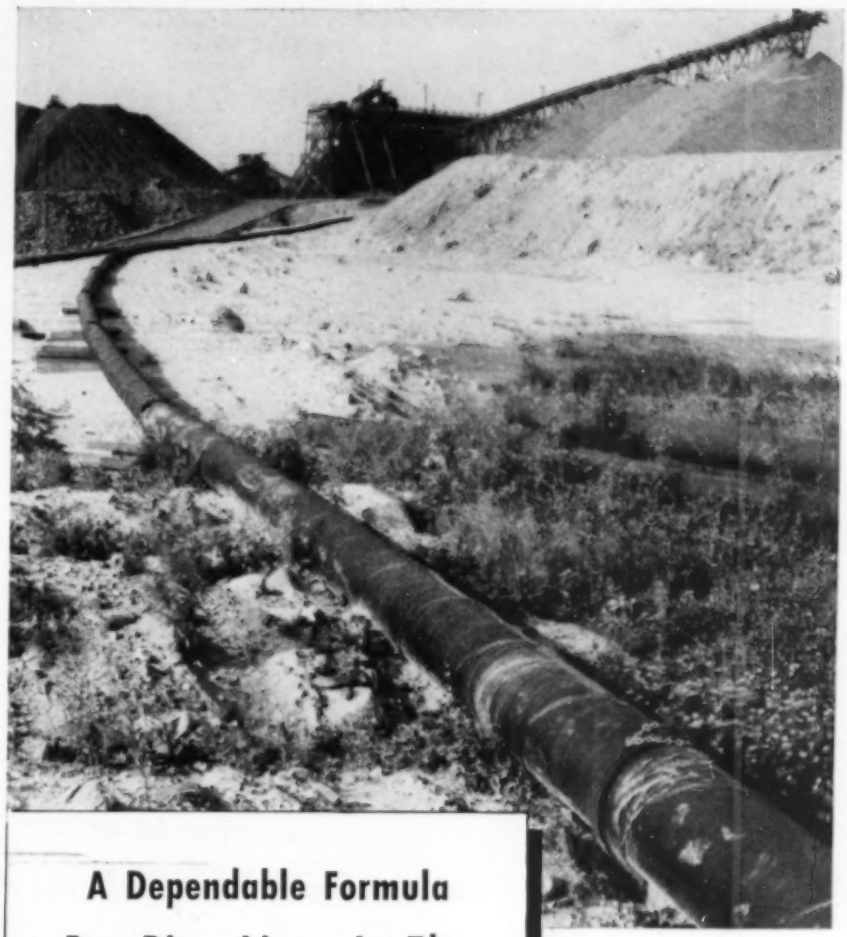
Nugent oiling devices for engines, pumps, compressors, presses, and other types of machinery are described in Bulletin 15 released by Wm. W. Nugent & Company, Inc. Oilers for crankpins, crosshead guides and pins, eccentrics, knuckle joints, main bearings, and fly wheels and clutches are among the many described and illustrated. A copy of the publication may be obtained by addressing the firm at 410-12 North Hermitage Avenue, Chicago 22, Ill.

Cochrane Corporation, Seventeenth Street & Allegheny Avenue, Philadelphia 32, Pa., has issued a 20-page bulletin on high-pressure condensate-return systems. Technical material on turbulent versus laminar steam flow and on the effects of air and condensate films on heat-exchange characteristics are given, as well as case histories of typical installations in heating, cooking, drying, and pressing operations.

Adhesives, sealers, and coatings designed for automotive, aviation, shipbuilding, and similar industries are discussed in a 28-page brochure offered by the Minnesota Mining & Manufacturing Company, St. Paul, Minn. Pictured and described are bonding operations such as plywood to metal and vinyl sheeting to wood; sealing operations involving aircraft cabins, automobile bodies, and boat decks; and protective and anti-corrosion coatings for metal.

SUBZERO MATTRESS

One of 200 air mattresses produced by Goodyear Tire & Rubber Company for the Army's survival test conducted in Alaska where winter temperatures go down to as low as minus 70-F. Because ordinary rubber-compounded materials become brittle and useless under such conditions, the pad is made of a nylon fabric impregnated with specially developed rubber. When inflated, the 27x76-inch mattress weighs only 2 pounds.



A Dependable Formula For Pipe Lines In The Mining Field

NAYLOR *Light-weight* PIPE
PLUS
NAYLOR *Wedge-Lock* COUPLINGS
EQUALS

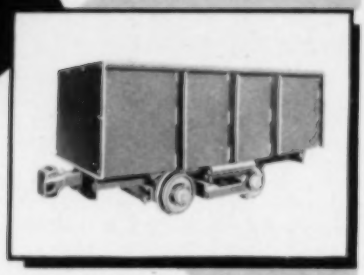
Stronger, Safer, More Economical Pipe Lines For Both High and Low Pressure Service

Sizes from 4 to 30 inches in diameter

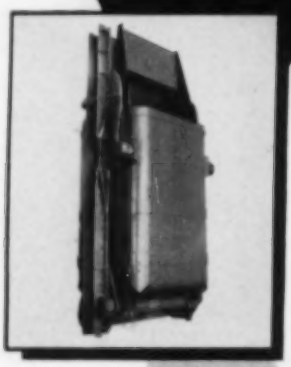
Naylor

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
New York Office
350 Madison Avenue, New York 17, N.Y.

Look TO LAKE SHORE for Leadership



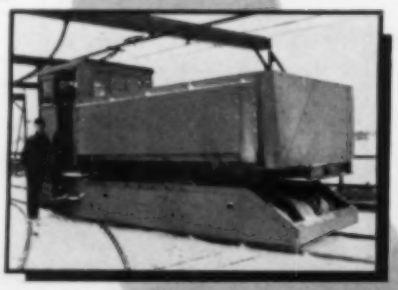
▲ Famous LoHed tram cars for economic hauling of ore and rock. Suitable for all dumping systems.



▲ Lake Shore builds steel, aluminum and steel, welded or riveted, skip and cage combinations to suit requirements.

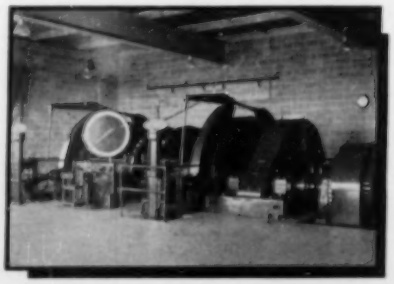
For seventy-five years Lake Shore Engineering Company has pioneered in the field of custom engineered mining equipment. Our wide experience in engineering and manufacture is available to help you solve your equipment problems. Built by men who know, understand, and live mining, Lake Shore equipment is serving the world. Write today for descriptive catalogs and literature.

▲ Open, semienclosed and fully enclosed designs of all types cages, steel and aluminum and steel construction.



◀ Three-way or five-way trestle dump cars. Dumps over both sides, end and both corners. A time saver on stockpiling.

Man and material, sinking, sub-level and cargo hoists. All latest improvements for maximum efficiency and safety, engineered to fit any requirement. Sizes to 10-ft. diameter. ▶



▲ Full line of carrying sheaves, rubber lined idler sheaves, split type and rotating shaft head sheaves. Cast iron, plate steel, or plate aluminum construction. Wide range of sizes.

LAKE SHORE
ENGINEERING COMPANY

IRON MOUNTAIN, MICHIGAN
Plants at Iron Mountain and Marquette, Michigan

Export Division
60 East 42nd Street, New York 17, New York
Cable address: LAKESHORE

Eastern Sales Offices
60 East 42nd Street, New York 17, New York
Telephone: MUrray Hill 2-3992

Wherever EXPLOSIVE FUMES *are present...*

Wagner *type HP* Motors give added protection...

For safe, dependable drives in explosive atmospheres, Wagner type HP Motors are a sound choice...

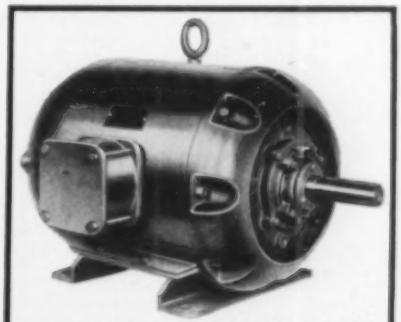
They have Underwriters' Laboratories approval for Class I Group D hazardous locations, where open-type motors might prove dangerous. They are *fully protected* against rain, snow, heat and dirt—so often found in oil fields. And they are unusually dependable!

These are three good reasons why Wagner type HP Motors were chosen to power the pumps, shown in the photo above, which are in continuous service twenty-four hours a day.

In addition, these protected-type motors are extremely economical to maintain—all that is required is periodic inspection and lubrication.

It will pay you to choose Wagner Motors for your next installation. They are a lasting investment. Twenty-nine sales and service branches, in principal cities are ready to help you on any motor problem.

Write for Bulletin MU-185 for information on the complete line of Wagner Motors.

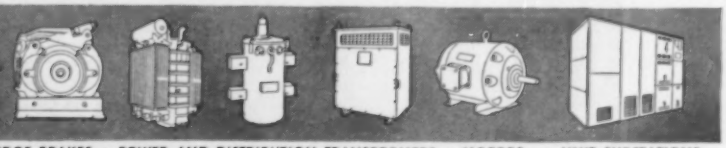


Wagner Explosion-Proof Motor for hazardous-location motor drives.

Wagner Electric Corporation
6418 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

Wagner Electric Corporation EST. WE 1891

Consult Wagner Engineers on all Electric Motor Problems



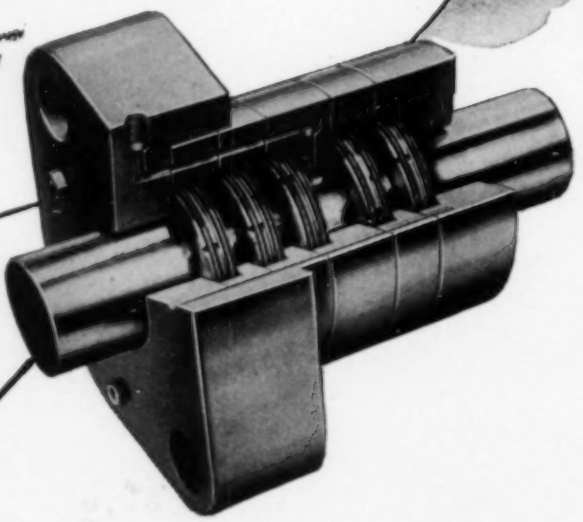
BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

ELECTRICAL AND AUTOMOTIVE PRODUCTS

M48-10

BETTER PACKING FOR MORE EFFICIENT RESULTS—THROUGH METALLURGY

There is no substitute for Cook Packing EXPERIENCE



★ . . . in dependability!

An engine or compressor is only as dependable as its component parts. This fact has been kept uppermost in mind in developing Cook Metallic Packing. Constant testing in field and laboratory by trained engineers under the direction of a metallurgist of national repute is the key to the superior dependability of Cook Packing — dependability based on 60 years of conscientious effort to develop materials that have the superior wear-resisting properties that make Cook Packing the best that money can buy.

As a result, Cook Packing is the accepted standard in many industries and is being used as original equipment in most severe service units building today where dependability really counts. So, when you order new equipment, remember there is no substitute for experience. Be sure to specify Cook Packing. For existing equipment, write us direct.

Sealing Pressures — Since 1888

C. LEE COOK MANUFACTURING CO.
INCORPORATED
LOUISVILLE KENTUCKY

BALTIMORE • BOSTON • CHICAGO • CLEVELAND • HOUSTON • LOS ANGELES • MOBILE • NEW ORLEANS • NEW YORK • SAN FRANCISCO • TULSA

Rock Crusher Drive Proves the Durability of *Texrope* *Super-7* V-belts!

Load! Shock! Grit! All these demons that destroy V-belts are present in this powerful rock crusher drive. But *Texrope Super-7* V-belts are giving long, satisfactory service, even under conditions like this. For big drive or fractional hp—for every type of service—get these famous V-belts from your nearby A-C dealer or office.

"PRE-ENGINEERED" TEXROPE DRIVES

You can solve 90% of all V-belt drive problems, from 1 to 150 hp with economical stock *Texrope* V-belts and sheaves. New 144-page manual makes drive selection as easy as finding a number in a phone book. Ask for Bulletin 20B6956. ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

Texrope, Super-7, Texsteel, Texdrive, Magic-Grip and Vari-Pitch are Allis-Chalmers trademarks

A Complete Range of Products		
Super-7 V-belts	5 types . . . sizes to suit every power transmission job	
Texsteel, Texdrive, Magic-Grip	Sheaves in a full range of sizes and grooves	
Vari-Pitch Sheaves	Exact variations in speed — Stationary or Motion control	
Speed Changers	Speed variations up to 375% at the turn of a crank	

Texrope Super-7 V-belts result from the cooperative research of Allis-Chalmers and B. F. Goodrich; and are sold only by A-C dealers and offices.

A 2429

ALLIS-CHALMERS

Originators of the Multiple V-belt Drive for Industry

Spearhead of Construction

When there's a tough rock job to be licked, make sure you've got good equipment to put down the holes fast and at low cost. It takes more than a sleek, purring compressor and rapid-fire drills. You've got to have tough, dependable drill steel.

Hard-rock men everywhere insist on Bethlehem Hollow . . . for they've found it stays on the job longer, speeding up the work. Here's why:

- ★ It's always true to size. The hole is smooth, true, and well-centered.
- ★ It forges readily to close dimensions.
- ★ Its wide quenching range means easy heat-treating.
- ★ Threads, shanks, and forged-on bits are tough, with the right degree of hardness to stand up under continuous drilling.

Bethlehem Hollow is ideal for either detachables or forged-on bits. Prompt shipment from your nearest supplier or our mill.

Modern equipment means fast rock removal. On this highway job in Pennsylvania the contractor relies on Bethlehem Hollow to help keep the drilling on schedule.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export distributor: Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

BETHLEHEM HOLLOW DRILL STEEL

Easier . . . Faster . . . Smoother Piping Jobs when CRANE-equipped throughout

For power, heating or process piping . . . whatever you need, Crane is the dependable source. Buying from the world's most complete line means delivery of what you want . . . valves, fittings, pipe, accessories, fabricated piping . . . in brass, iron, steel or alloys.

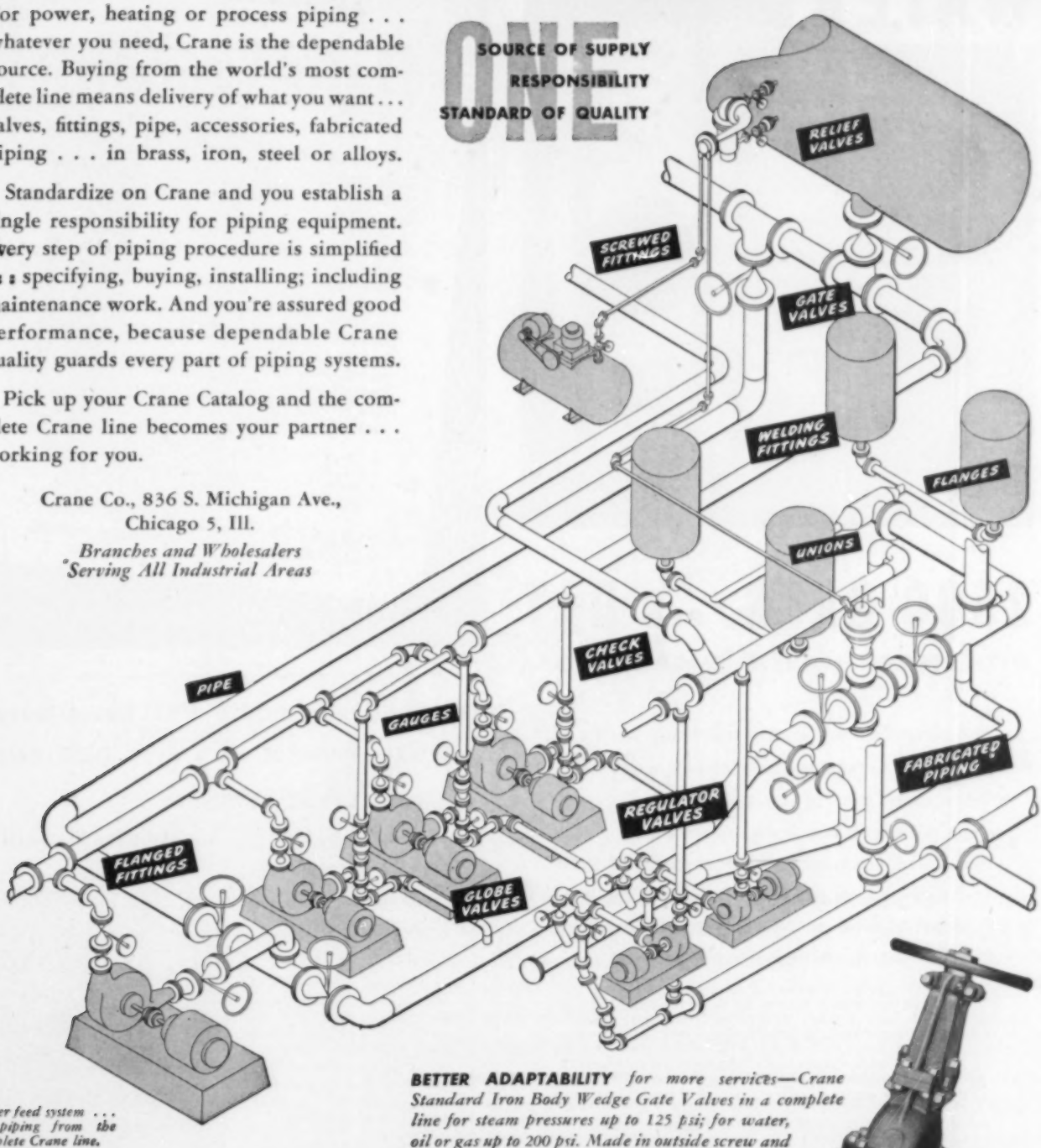
Standardize on Crane and you establish a single responsibility for piping equipment. Every step of piping procedure is simplified . . . specifying, buying, installing; including maintenance work. And you're assured good performance, because dependable Crane quality guards every part of piping systems.

Pick up your Crane Catalog and the complete Crane line becomes your partner . . . working for you.

Crane Co., 836 S. Michigan Ave.,
Chicago 5, Ill.

Branches and Wholesalers
Serving All Industrial Areas

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



Boiler feed system . . . all piping from the complete Crane line.

BETTER ADAPTABILITY *for more services—Crane Standard Iron Body Wedge Gate Valves in a complete line for steam pressures up to 125 psi; for water, oil or gas up to 200 psi. Made in outside screw and yoke, and non-rising stem patterns; screwed or flanged ends; brass-trimmed or all-iron. In sizes 2 in. and larger. See your Crane Catalog, pp 101-6.*

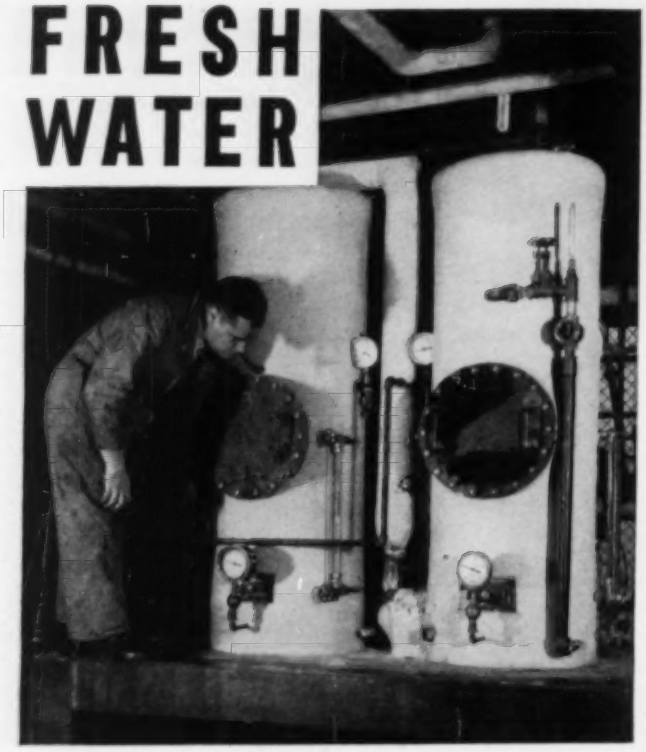
EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

FRESH WATER



2500 GALS. PER DAY

WITH THESE MAXIM EVAPORATORS

The picture above shows a test being run on a double effect evaporator hook-up before shipment. These evaporators produced 2500 gals. of fresh water per day. It is a low pressure set-up . . . all Monel and produces water to a purity of 2/10 grains of solid per gallon or 3½ parts per million. It shows 5 lbs. steam admission and 18 inches mercury vacuum on the second effect.

Wherever fresh water is a problem, Maxim Evaporators provide a practical answer. The design of Maxim Evaporators cuts upkeep to a minimum. They have operated as long as 2000 hours without major overhaul and are designed for easy descaling. Write to our engineering department for details.

THE MAXIM SILENCER COMPANY
61 HOMESTEAD AVE. HARTFORD 1, CONN.

BE SURE IT'S A

MAXIM

BURGESS SNUBBERS · BURGESS SNUBBERS

ASSURANCE OF A

• Quiet intake

Don't put up with troublesome pumping noise at the intake of your compressor or blower, or the discharge from a vacuum pump. Install the correct size Burgess Snubber and eliminate the noise problem easily.

When you eliminate noise, you may also improve compressor operation, because a Burgess Snubber eliminates tuning pipe length to obtain best efficiency. It smooths the flow of air without choking or restricting air flow.

P.S. A Burgess-Manning Combination Air Intake Cleaner - Snubber is also available for air cleaning plus quieting. Write for full information.

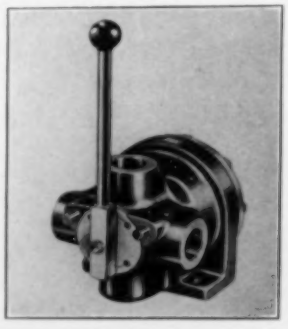
BURGESS-MANNING COMPANY
749-P EAST PARK AVE., LIBERTYVILLE, ILLINOIS

BURGESS SNUBBERS · BURGESS SNUBBERS

VALVE . . . 5000 PSI heavy-duty 4-way Selector . . . 1½" pipe size

Source: SAVAL COMPANY
1903 E. 51st St., Los Angeles 11, Calif.

Extremely low handle load, leak-proof design and long service life are outstanding features of SAVAL'S No. 8298 heavy-duty, 5,000 PSI, 4-way selector valve.



Designed for service with oil, water or gas for pressures up to 5,000 PSI the valve has a rugged bronze body with heavy-duty construction throughout. Integral stops and balanced detents assure smooth, trouble-free operation.

It employs SAVAL'S patented "Shear-Seal" principle. This provides a metal-to-metal seal that is self-aligning and automatically compensates for wear. Not critical to dirt because foreign materials are wiped away instead of lodging between the sealing surfaces. Only one basic moving part. May be serviced without removing from lines. Requires no lubrication or packing adjustment throughout its life. Good for 1,000,000 cycles under most severe and exacting conditions.

Send for details on No. 8298 or for catalog on complete line of industrial valves. SAVAL specializes in furnishing valves to meet your specific requirements. On specials, please indicate pipe size, operating pressure and fluid used. Quick service from regional representatives.

WHY A TREADED LEATHER BELT?

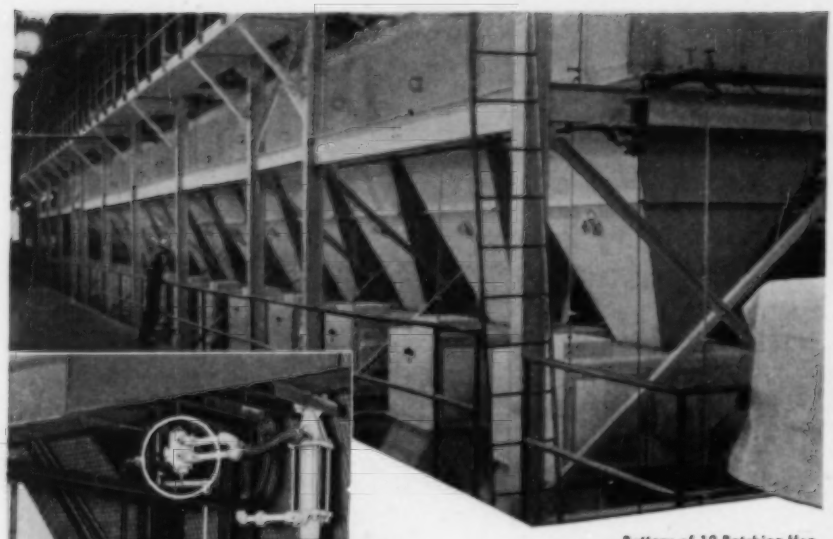
Graph shows benefit of treading." An 8" VIM Leather belt was cut into two 4" belts; one was treaded. Then slip tests were run — 2800 FPM, 30" diameter pulleys — with above results.

Plant men know that leather belts excel for the long, hard pull in power transmission. But only those who have used VIM Tred Leather can appreciate what this patented tread, exclusive with Houghton, means for greater pulling power and decreased slip.

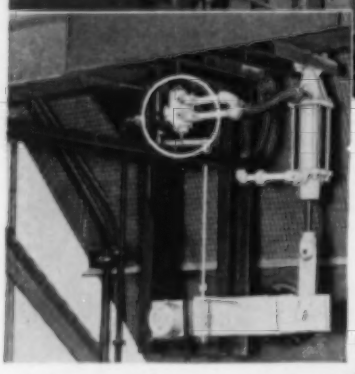
We start with the best mineral tannage, which shrinks, rather than artificially plumps, the hide. We have to use heavy hides, which were scarce during war years, but are again available. Then, with a naturally high coefficient of friction on the VIM leather surface, we add a tread to "gear" the belt to the pulley. The result is efficient, long-life power transmission.

Make your next belt the best belt you ever bought; make it a VIM Tred, made only by E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa. and all principal cities.

HOUGHTON'S VIM-TRED LEATHER BELTING



Battery of 18 Batching Hoppers in a large food processing plant.



NOPAK Reciprotrol Valve and Model E Cylinder, on each hopper, operate shakedown mechanism automatically.

AUTOMATIC "SHAKE-DOWN" for 18 Batching Hoppers is NOPAK Operated . . .

This block-long battery of hoppers is used for measured mixing of product ingredients. Running thru each hopper is a rotating shaft, with paddles, connected to a NOPAK Model E Hydraulic Cylinder. As the cylinder reciprocates, the paddles shake down the dry *ingredients* which drop into glass-enclosed weighing batchers.

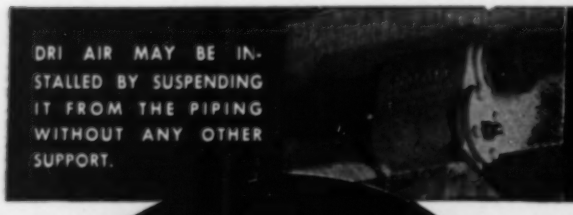
Each of the 18 cylinders reciprocates 20 times per minute, 18 hours a day. This continuous reciprocating action is governed by 18 NOPAK Reciprotrol Valves. The entire mixing process is fully automatic . . . controlled from a central switchboard by 2 operators.

NOPAK Reciprotrol Valves can help you achieve automatic control of cylinder action in your plant, or in your product. Write for Illustrated Bulletin.

Representatives in Principal Cities

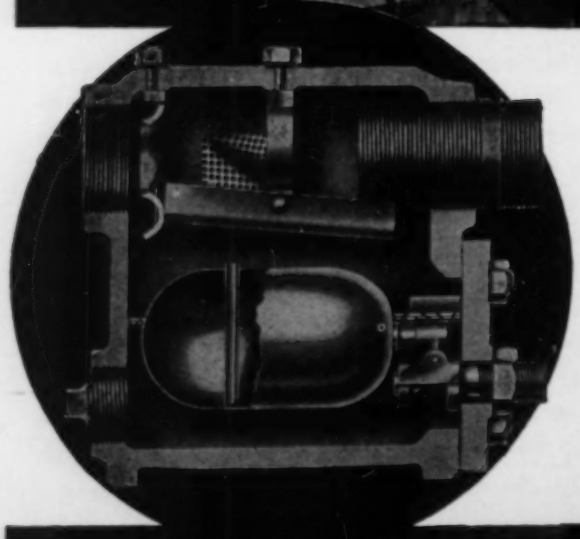
NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

GALLAND-HENNING MFG. CO.
2759 S. 31st Street Milwaukee 7, Wis.



DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

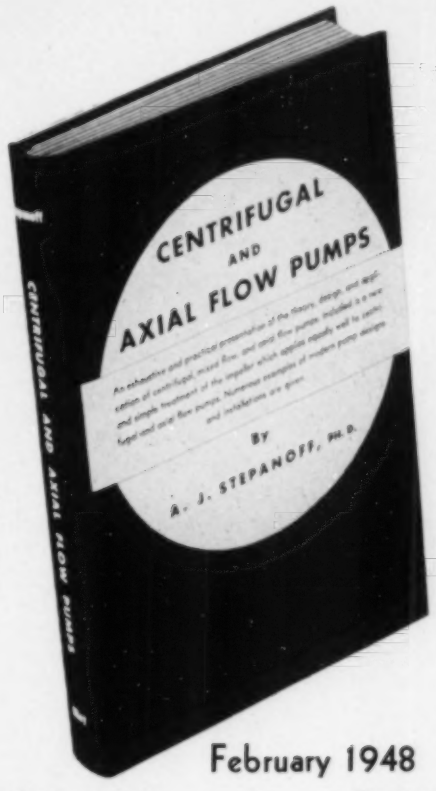
A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY



NOW...

First Book-length Study

of

CENTRIFUGAL AND AXIAL FLOW PUMPS

By A. J. Stepanoff, Ph.D., *Ingersoll-Rand Company*

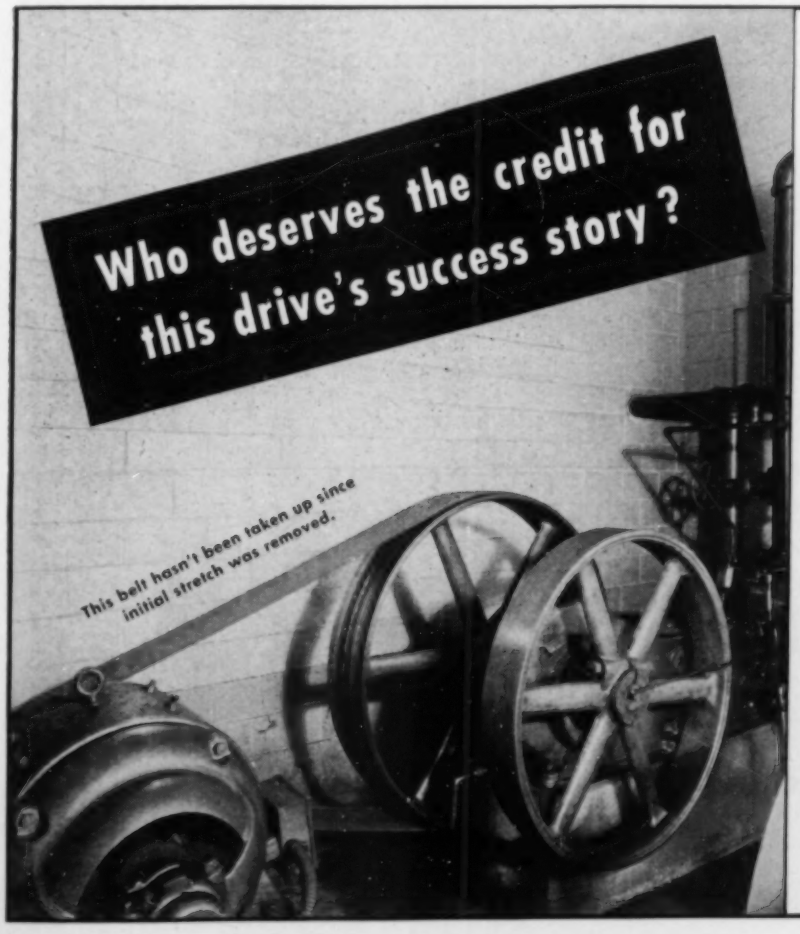
A study of centrifugal and axial flow pumps that's *not* just a discussion of elementary theory. It is one of the most complete working manuals ever available to pump engineers in this country.

Theory, design and application are the three broad divisions of the book. In the first five chapters, Dr. Stepanoff covers the theoretical background necessary for understanding recent developments. Chapters Six through Twelve are devoted primarily to design, including impeller and pump casing design, losses in centrifugal pumps axial thrust, cavitation, and pump design for critical speeds. Finally, the author discusses the problems encountered in operating centrifugal and axial flow pumps and deals with the precautions necessary to insure satisfactory operation.

February 1948

428 pages $7.50

Compressed Air Magazine, 942 Morris St., Phillipsburg, N. J.



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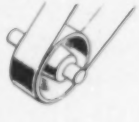

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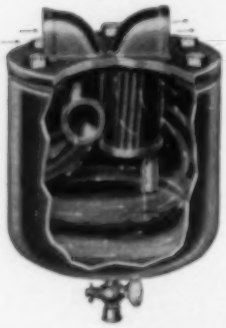

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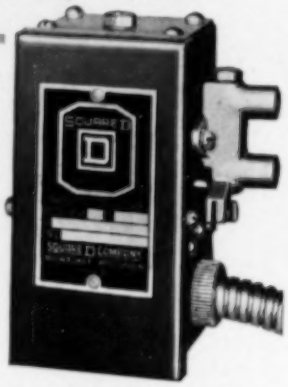
New CLASS 9045 TYPE BG **MAGNETIC UNLOADER**

Provides POSITIVE unloading of air-compressor at end of operation or when voltage failure occurs

FEATURES



- Release valve is located conveniently on the side of the unloader enclosure. Moisture, condensed by the rapid expansion of the unloaded air, is blown into the atmosphere. The solenoid coil and interior working parts remain dry and free of moisture.
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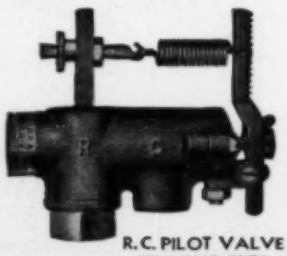

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TODAY'S BEST BET FOR SAFETY
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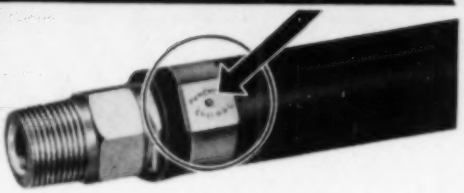

The Punch-Lok Method for clamping hose is approved and used as original equipment by manufacturers of compressors, rock drills, and other air-operated tools. Punch-Lok Clamps are leakproof and lay flush with hose cover. They are safe, efficient, and low-cost.

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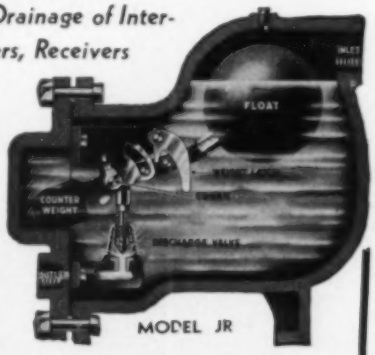
Nicholson Air Traps

STOP Corrosion Trouble

Promote Positive Drainage of Intercoolers, Aftercoolers, Receivers



All internal parts of Nicholson air traps are made of bronze and stainless steels, carefully selected to give permanent resistance to the corrosion problems arising in the drainage of water and oil. Other trouble free features resulting in the adoption of Nicholson traps as standard by an increasing number of large trap users: positive fluid seal against loss of air; not easily affected by dirt, pulsation, pressure variations; non wire drawing; rugged to take unavoidable abuse.

Air Traps for Every Industrial Application

Types for all pressures to 1500 lbs.; the product of over 30 years experience in air trap designing.

BULLETIN 1047

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stand the gaff

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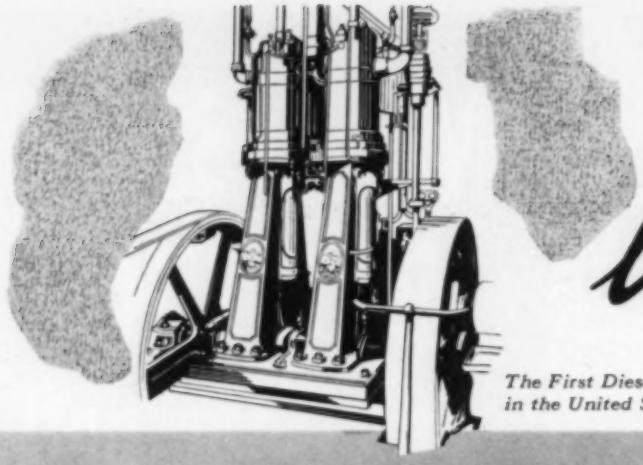
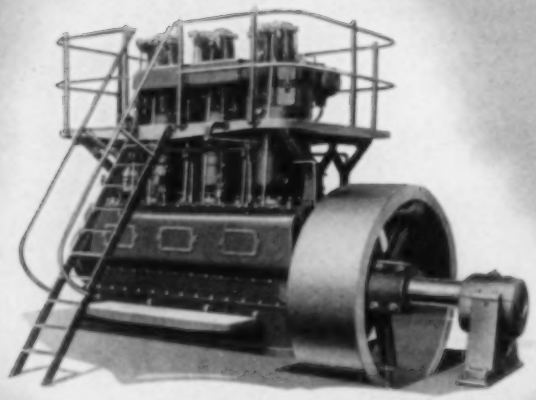


it started

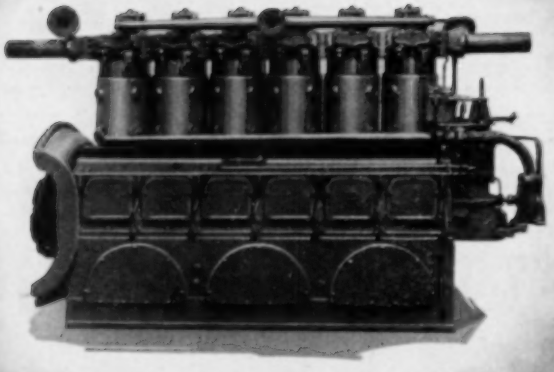
The First Diesel Engine Built in the United States.

AND THEN IN 1918



...when high-pressure air was universally used in America and Europe for the injection of fuel in a Diesel engine, Ingersoll-Rand pioneered in the development of solid injection. This development was so successful that in 1923 Ingersoll-Rand licensed Usines Carles Freres of Ghent, Belgium, to build Ingersoll-Rand solid injection engines. Today solid injection has completely replaced air injection except in engines of very large horsepower.

AGAIN IN 1923



...when Diesel engines operated at 200 revolutions per minute and weighed 300 pounds per horsepower, Ingersoll-Rand developed a Diesel engine for locomotive service, operating at 600 revolutions and weighing 55 pounds per horsepower. This was the first Diesel-electric locomotive in the United States and there are over 150 engines of this original Ingersoll-Rand design in successful everyday service. These engines led the way for today's modern Diesel-electric locomotives.

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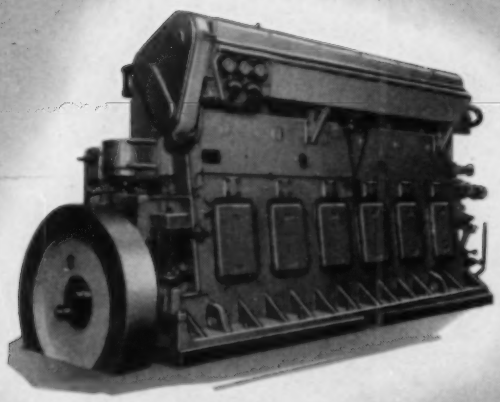
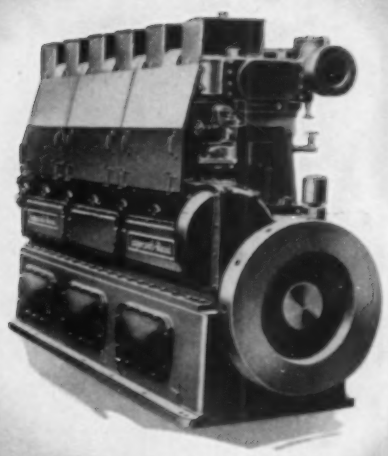
in 1898

AGAIN IN 1929



...when Diesel engines were of the individual-cylinder type, Ingersoll-Rand brought out a fully enclosed engine with a girder-type housing which incorporated the horizontal stiffness of the water-box type without the dangers of water stagnation. This is today's standard for Diesel engine construction.

AND NOW IN 1948



...Ingersoll-Rand Type "S" and Type "SS" supercharged Diesels represent one of the first applications of higher speed, medium weight Diesels to heavy power service. The research and development that has gone into the manufacture of I-R Diesel engines during the past thirty years is responsible for the extreme compactness, the easy accessability and the unusually low fuel consumption of today's I-R Diesels. Sizes range from 225 to 600 hp for the 3 to 8 cylinder Type "S", and 675 to 900 hp for the 6, 7 and 8 cylinder Type "SS".

169-7

• OIL AND GAS ENGINES

Ingersoll-Rand

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BUY **LE-HI** HOSE COUPLINGS FOR HIGH PRESSURE AIR LINES

Construction men take no chances. They know that every length of hose and every hose coupling is a vital factor in the safety of both men and equipment.

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LE-HI Series 150-B. The only Universal Type Hose Coupling with the patented "Safety-Locking" feature that positively prevents accidental uncoupling. Especially designed for compressed air service.

SAFER, because of LE-HI's advanced design . . . shanks and clamps that won't "blow off" . . . LE-HI Series 150-B, the only Universal Type Couplings with the patented "Safety-Locking" feature that positively prevents accidental uncoupling. . . .

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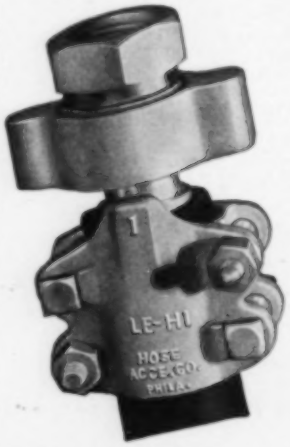
Construction is booming everywhere. Be ready for your part in the program with *safe, efficient* equipment. And be sure that every air line has LE-HI—the SAFER, TOUGHER Hose Couplings!



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Prevents rust and corrosion when tool is idle.

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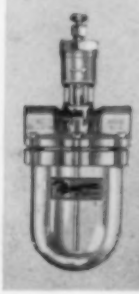

Norgren

This
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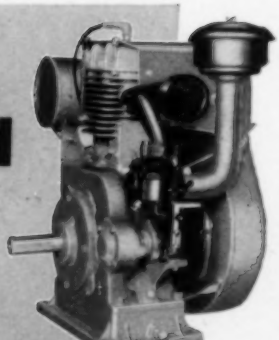
WISCONSIN
Air-Cooled
ENGINE *is*
Available in 4
Sizes . . . 4 to 9 H.P.



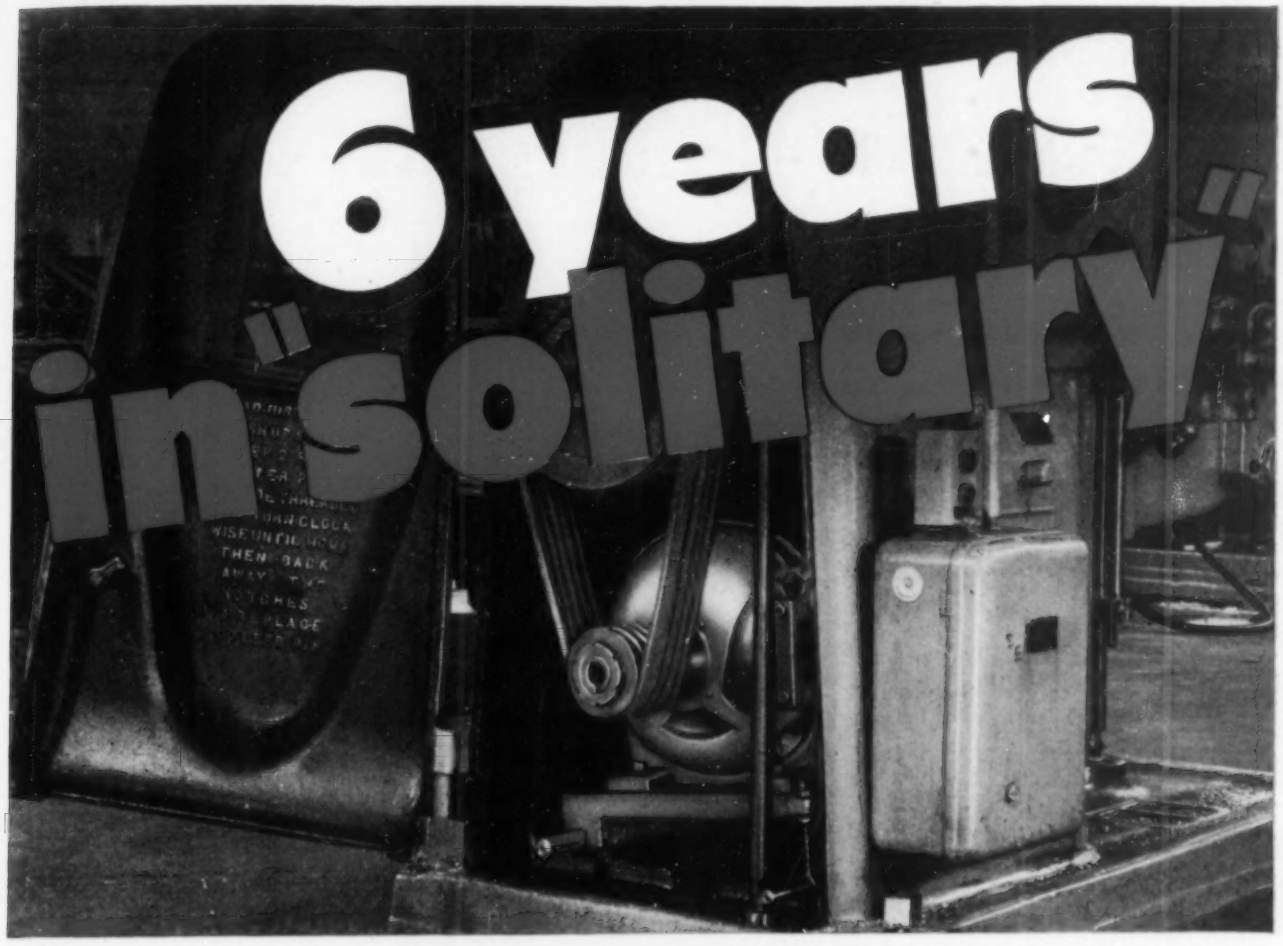
Illustrated above is the Models AEH to AHH series of 4-cycle single cylinder Wisconsin Air-Cooled Standard Engines, to which the following specifications apply:

MODEL	AEH	AFH	AGH	AHH
Bore	3"	3¼"	3½"	3⅝"
Stroke	3½"	4"	4"	4"
Cu. in. Displ.	23	33.2	38.5	41.3
Hp. Range	4-6	5-7	6-8.5	7-9
Weight	130 lbs.	180 lbs.	180 lbs.	180 lbs.

If your equipment calls for an engine within the above power range, it will pay you to give serious consideration to the Wisconsin line . . . noted for rugged, heavy-duty serviceability and thorough-going dependability.

In addition to the engines listed above, Wisconsin 4-cycle single cylinder engines are also available in 2 to 4 hp. sizes, and V-type 4-cylinder engines can be supplied in a power range of 13 to 30 hp. Detailed data furnished on request.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN



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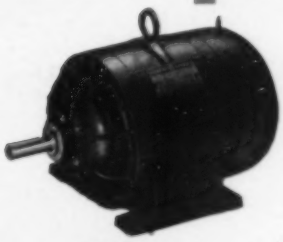
Six years ago, the Bell Aircraft Corp. installed in its Buffalo plant many machine tools which had G-E Tri-Clad motors tucked away inside. Operating in confined quarters where the volume of cooling air was limited (and laden with oil), these sturdy Tri-Clads toiled 24 hours a day, 7 days a week all through the war years. At a time when manpower for motor maintenance was almost unobtainable, these motors proved they had the "stuff" to stay on the job with only the barest amount of attention.



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Installation studies like this prove this important fact—when there's a tough motor job to be done, you can't beat Tri-Clad extra protection. Over 1,500,000 Tri-Clad motors have been built. All of them feature cast-iron enclosures, improved winding and insulating techniques, and advanced bearing design. All are equipped with *extra protection* against physical damage, *extra protection* against electrical breakdown, and *extra protection* against operating wear-and-tear. That is what "Tri-Clad" means—better motor performance at less cost through maximum motor protection.

NOW . . . A TOTALLY ENCLOSED TRI-CLAD!

We believe the new Tri-Clad totally enclosed induction motor is industry's most dependable motor. It is designed for use in adverse atmospheres—in iron dust, out-of-doors, in hazardous areas, and chemical atmospheres. It is available in both standard and explosion-proof enclosures. Call or write your nearest G-E field office for more information today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

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GENERAL ELECTRIC

760-4C

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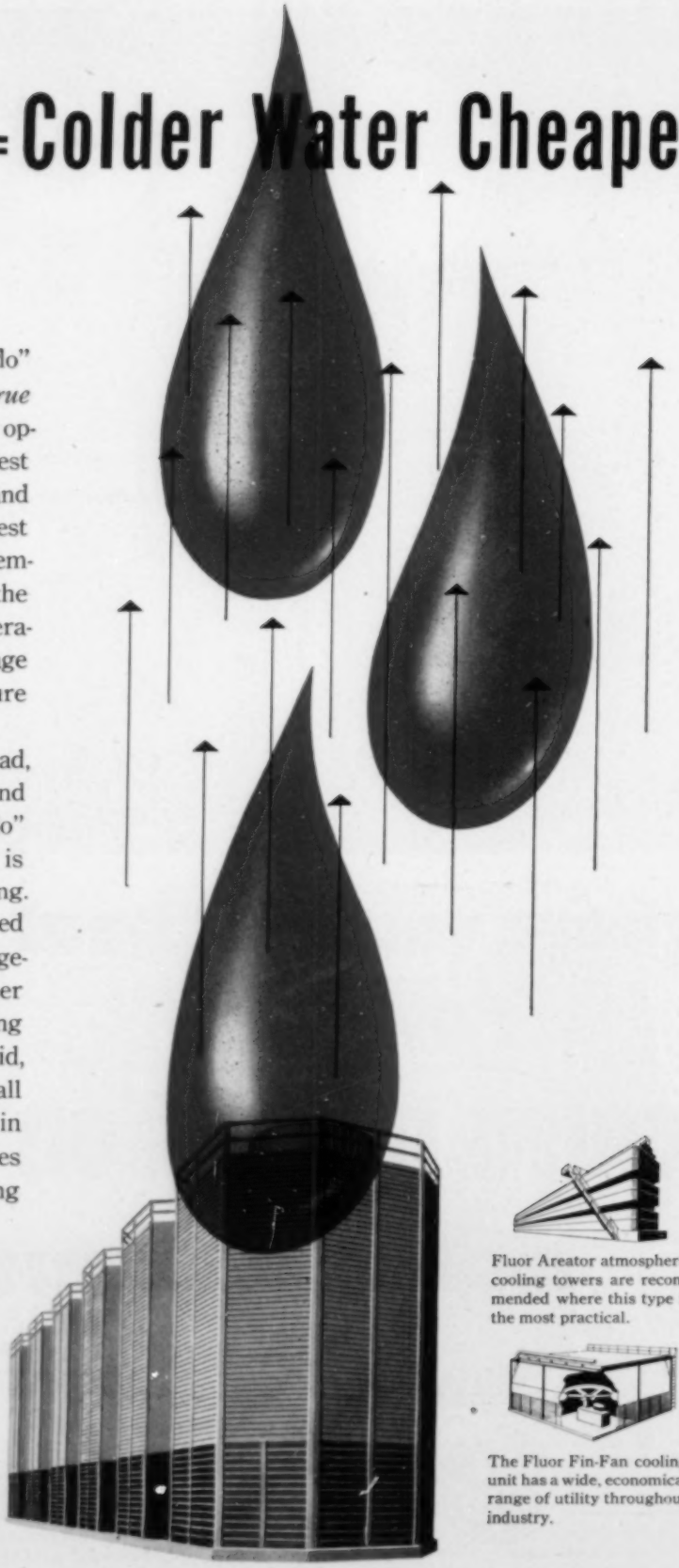
Cheaper? Yes, and here's why: Fluor "Counterflo" Cooling Towers incorporate the principle of *true* counterflow: the air current travels directly opposite to the water current. Result? The coldest air contacts the coldest water; the hottest and most humid air (exhaust) contacts the hottest water. All the exhaust air approaches the temperature of the incoming hot water while all the cooling water approaches the wet bulb temperature of the entering air...thus taking advantage of the greatest possible terminal temperature differential so vital to efficient heat transfer.

Assuming tower size, tower height, heat load, water circulation, wet bulb temperature and air quantity are equal, the Fluor "Counterflo" Cooling Tower will deliver colder water than is possible with either parallel or crossflow cooling.

The Fluor octagonal tower design; patented up-spray distribution nozzles; proper arrangement of grid decking to assure longer air-water contact; fan and gearing developed to give long service life and eliminate recirculation; rigid, time-resistant construction throughout... all add up to one net result: less operational cost in the long run. Yes, fifty years' experience proves that... year in and year out... Fluor Cooling Towers deliver colder water cheaper!



6 Cell "Counterflo" Cooling Tower

Fluor "Counterflo" induced draft cooling towers, prefabricated in mass production, are available in multiple or single units in any required size or height.

Fluor Areator atmospheric cooling towers are recommended where this type is the most practical.

The Fluor Fin-Fan cooling unit has a wide, economical range of utility throughout industry.

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Tannate-Rockwood Short Center Drives—a reliable combination of Tannate Flat Leather Belt, Rockwood Pivoted Motor Base and Pulleys—assure constant, uniform speeds . . . higher hourly production . . . more uniform work . . . fewer shut-downs . . . and less wear on bearings and belt.

Tannate Flat Leather Belt provides long, trouble-free belt life; requires fewer take-ups and less maintenance; resists high temperatures, water, machine oils and many chemicals. Pivoted motor base automatically maintains correct belt tension regardless of load fluctuations.

Write for detailed information about this cost-reducing, production-increasing combination.

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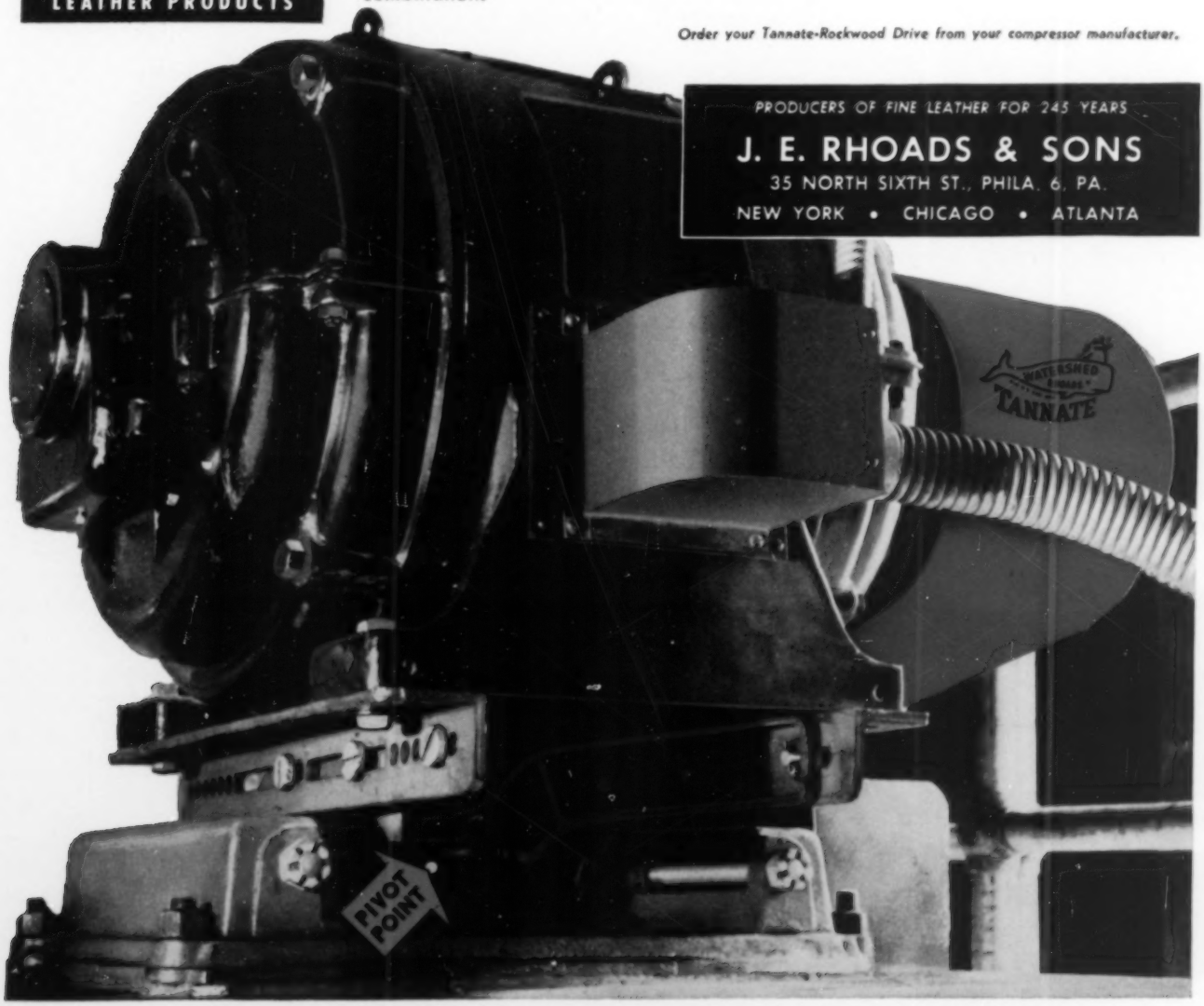
Order your Tannate-Rockwood Drive from your compressor manufacturer.



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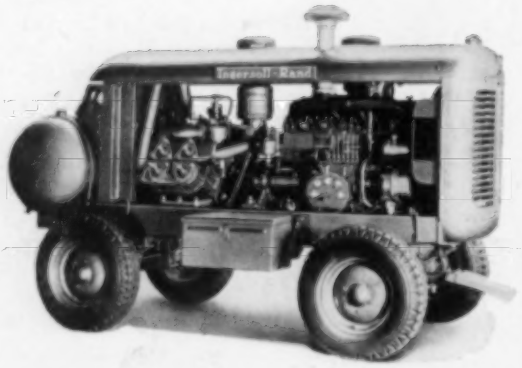

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For the clean valves that mean full air pressure, lubricate your compressors with *Texaco Cetus, Alcaid or Algol Oil.* These oils have been especially refined to remove the impurities that form hard carbon deposits.

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FOR BETTER DRILL PERFORMANCE use Texaco Rock Drill Lubricants EP. They prevent rust in service and in storage, resist washout, protect moving parts against wear even in the severest service. They meet the requirements of leading rock drill manufacturers.

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